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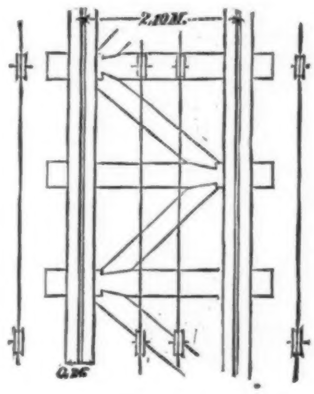
THE NEW RAILWAY UP MOUNT VESUVIUS.

THE Italian railway lines have lately received two very interesting additions, which, although they both relate to mountains, are perfect extremes, the St. Gothard and the Vesuvius railways. Both have justly attracted the attention of the world, for they are both grand undertakings. To ascend Mount Vesuvius is by no means an easy task, especially for ladies, as the mountain is covered with a coarse volcanic sand, which causes inexperienced persons to slip at every step, so that it requires from two to three hours to ascend the last cone.

The grade up to the valley in which the observatory is situated, 1,840 feet above the ocean, is from three to fifteen degrees, and this point can be reached by means of the splendid carriage road from Resina. After a rise of about 650 feet, the bottom of the final cone, which is about 1,950 feet high, is reached. It is here where the greatest difficulties are encountered, for the slopes have inclinations of thirty to fifty-eight degrees, so that it is almost impossible to get along without the aid of men who act as guides or pushers, the ascent being thus made a very costly affair. This was the main cause that induced several enterprising men to organize a company and raise the money to build a railway to the top of Mount Vesuvius. The Milanese engineer, Emilio Olivieri, drew up the necessary plans and began operations in October of 1879.

The lower station of the railway is about 1¼ miles from the Palmieri observatory, and is situated about 325 feet higher than the same. The carriage road from the observatory to the lower station passes over the broken lava of the eruption of 1872, and was built by the Venetian engineer Dall' Ongaro. The line of the new railway was so located on the sea side of the mountain so as to be protected as much as possible from lava streams and showers of ashes. The immense grade of fifty-six and one-half degrees (63 feet in 100) excluded all other systems of railways except the cable road with stationary engines. The greatest difficulties were experienced in procuring safe and solid foundations for the upper and lower stations and for the road bed, but fortunately the cone of Vesuvius is traversed by several streams of lava, the upper crusts of which vary in thickness from eight to thirty-one inches, and afford sufficient resistance for the railway and buildings. There are nine lava beds of greater or less thickness throughout the entire length of the 2,688 feet of the railway. The lower station, the engines of thirty horse power, rope drums, and about 330 feet of track rest on the lowest lava bed. A part of the track foundation rests on the next bed, and so on to the uppermost lava bed, which is about 460 feet from the top of the cone.

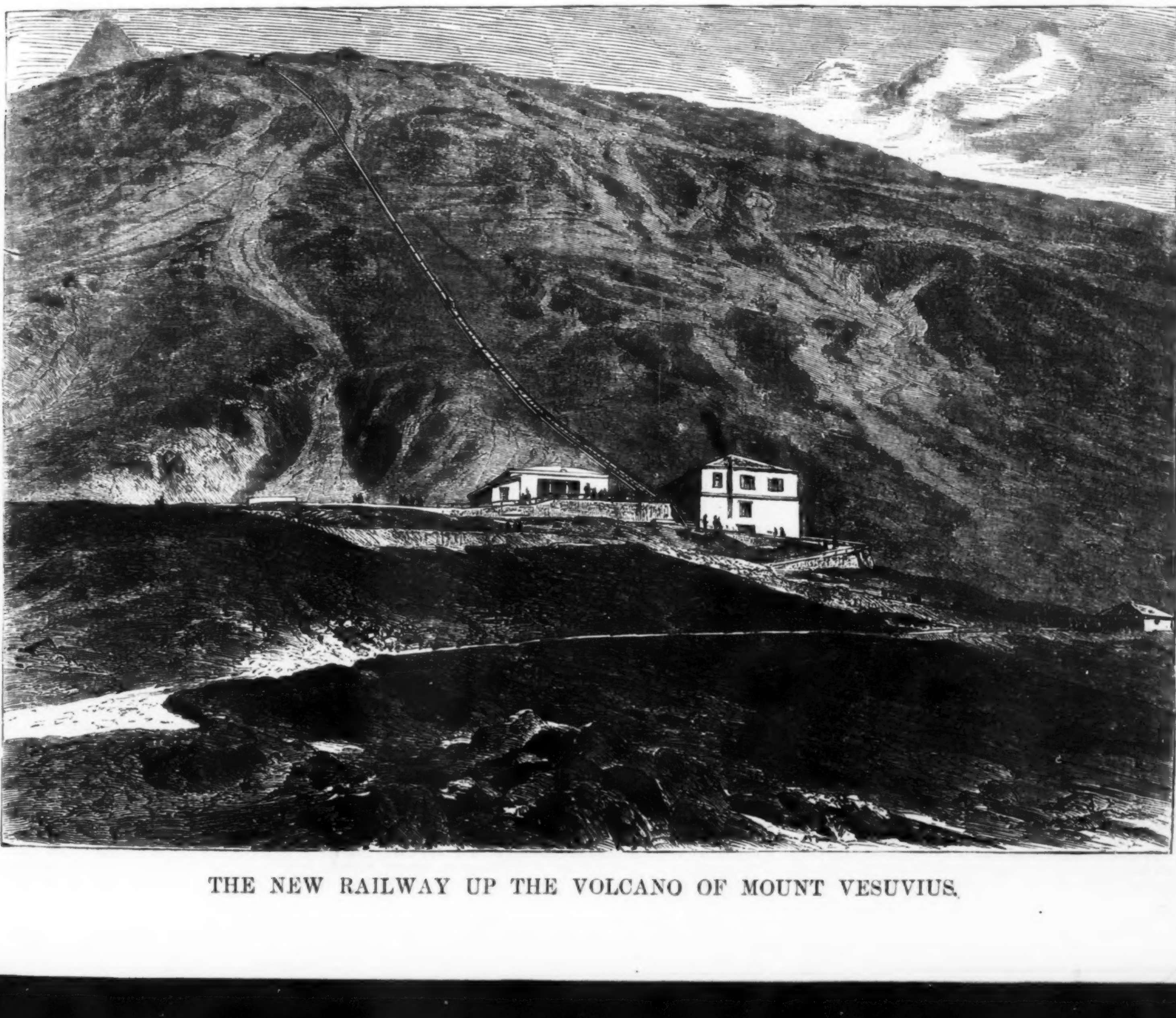
The sleepers are connected by diagonals mortised into



them, and by the oaken longitudinal rail supports of ten by eighteen and one half inches, which are connected with the sleepers by strong bolts, and carry one rail on their upper surface. An enormous ladder has thus been constructed and placed against the side of the mountain, and rests upon the lowest lava bed of the cone. There are two cables, one inch in diameter, and consisting of forty-nine strands of steel wire, for each car. They were tested at twenty tons before delivery. The cables pass over pulleys arranged fifty feet apart throughout the length of the road. As there is no lava bed at the upper end of the road, and as it was impossible to build a foundation for the upper cable drums in the loose sand only, the engineer built two walls of 330 feet in length, which convey the pressure of the foundation of the upper station to the uppermost bed of lava, so that the said bed supports the entire weight of the propelling devices—no doubt a very genial, but nevertheless very daring expedient. There are two cars on each rail, each car being provided with two compartments for six persons each, so that twelve persons can be conveyed up and twelve down at each trip. The car bodies rest on iron frames, provided with a wheel in the front and rear, and with side wheels, rolling on rails attached to the side of the longitudinal rail supporting beams to prevent the cars from upsetting. A conductor has a seat in the front of each car, and controls the braking device, consisting of two toothed metal blocks, which catch in the longitudinal supporting beams. The time required by the cars to go from one station to the other is from seven to eight minutes. An elegant restaurant will be built in the Pompeian style, next to the lower station, and the two stations are connected by telegraph wires, the lower one being also in telegraph connection with the rest of the world.

The water for the boilers is collected in large cisterns from the tile roofs of the buildings. The entire cost was 400,000 francs, but it is expected that the road, which is under the direction of Mr. E. Gamond, will yield a handsome profit to the owners.

Great trouble was experienced in building the road, as every beam, bolt, etc., rolled down the smooth side of the mountain immediately, the workmen had no sure footing, and were molested by the wintry winds, fumes of sulphur, and the continual expectation of an eruption. The road is completed and given to public use, but how long it will be before old Vesuvius will have his say, in form of a stream of lava or a shower of bowlders and ashes, no one can tell. Prof. Palmieri, the celebrated director of the Vesuvius observatory, has declared himself against the railroad, and says he will never travel upon it.—*Ernst v. Hesse Wartegg, in the Leipziger Illustrirte Zeitung.*



THE NEW RAILWAY UP THE VOLCANO OF MOUNT VESUVIUS.

THE ST. GOTHARD TUNNEL.

WE have on several occasions briefly reported the progress that has been made in the works of the St. Gothard Tunnel, and we now publish an interesting communication recently made to the French Academy of Sciences by Dr. Colladon, of Geneva, who is well known as the inventor of the air-compressing apparatus, the employment of which has contributed so largely to the success of this grand work.

NOTES ON THE JUNCTION OF THE TWO GALLERIES OF THE ST. GOTHARD TUNNEL.

By Dr. COLLADON.

The two galleries of the St. Gothard Tunnel, which together represent a length of 16,813 yards, or rather more than 9¼ miles, have just been united after seven years and five months of continuous working, the junction thus effected having proved to be remarkably true and exact.

These two results, which are of so much importance to the art of construction and to the future junction of several main lines of railway, are of universal interest, and the author believes that the members of the Academy will welcome a short account of the progress of the work, together with a few notes respecting the long series of obstacles and exceptional difficulties which were encountered, and which frequently impeded the work of excavation.

The most efficient means of accelerating this great work were the remarkably ingenious arrangements for diking the torrents, and the application of the motive power of water collected in aqueducts to turbines for high water-falls; the adoption of a new system of high-speed air-compressors; the cooling of the air in the compressing cylinders at the instant of compression by means of an injection of water in the state of fine spray; the many important improvements in the boring machines and their frames; the use of dynamite; and the decision adopted from the first by the late able contractor, M. L. Favre, of Geneva, to commence tunneling from the top, and the practical knowledge, rare intelligence, large experience, and indomitable energy of the latter. Such were the main elements which have enabled the contractor and his engineers to force their way through the hard and irregular rocks of the St. Gothard with a speed nearly double that which was attained by the able engineers who were charged with the piercing of Mont Cenis.

The tunnel through the last-named mountain, which has a total length of 13,0 9 yards, or nearly 8¼ miles, was commenced simultaneously from both ends as far back as the month of September, 1857, and the two galleries were joined on the 25th of December, 1870, the deviation being found to be about 13 inches. On the other hand, it may be predicted that, notwithstanding its greater length, the St. Gothard Tunnel, when finished, will have cost from 25 to 30 per cent. less than that of the Mont Cenis.

It is therefore obvious that the remarkable success which has been achieved in the St. Gothard Tunnel has inaugurated a new method of cutting speedily and economically tunnels of great length.

At the commencement of this paper allusion has been made to a series of exceptional difficulties which have at times impeded the progress of the excavation, and in order to show their importance it is necessary to explain the conditions that were imposed upon the contractor, and the position of the late M. Favre with respect to the company which had charge of the construction of the St. Gothard Railway and of the lines of approach on both slopes of the mountain. This company had appointed M. Gerwig as their chief engineer, and a numerous staff of engineers was chosen to assist him.

The construction of the main tunnel, 16,318 yards in length, having its northern opening near Goeschenen at an altitude of 1,213 yards, its southern opening at Airolo at 1,254 yards, and its highest central point at 1,263 yards, was to be given to one contractor, who was to deposit a guarantee of eight millions of francs (£320,000). This contractor was to cut the entire tunnel; to undertake, at his own cost, the diverting of the torrents; to furnish the whole of the hydraulic apparatus, the air compressors, and the mains; all the boring, transport, and ventilating machinery; all the necessary buildings, including workshops, sheds, workmen's houses, etc.; to undertake the entire excavation of the tunnel for a double line, and, in case of requirement, to supply all the masonry work, according to the plans furnished by the chief engineer. The site of the tunnel and its approaches, its inner slopes, and the verification of the center line of the two galleries were left to the railway company.

The chief engineer had limited the gradient of the southern half of the tunnel to one-thousandth part of its length; but he had not foreseen the enormous quantity of water which would be met with in this half of the gallery, and the disastrous consequences which would result therefrom.

In the Mont Cenis the volume of infiltration at each end did not exceed 0·22 gallon per second.

In the Mount Hoosac Tunnel, in Massachusetts, a maximum infiltration of four gallons per second was found to present a serious obstacle to the work of excavation.

In the southern gallery of the St. Gothard, with the slight incline of one foot in 1,000, at the end of the first year after the commencement of the tunnel the volume of infiltrated water reached the amount of 50 gallons per second, or 176,400 gallons per hour, and the headway gallery, the average section of which is from 65 to 75 square feet, was, for nearly three years, converted into a veritable aqueduct, in which the water rose to a height of from 0·98 in. to 1·18 in., the water occasionally attaining a volume and a speed comparable to the jet of a fire engine.

To the difficulties produced by these infiltrations of water were sometimes added the occurrence of faults, which discharged into the gallery torrents of mud and *debris*.

Outside the tunnel the hydraulic motive power was found to be insufficient during the winter months.

During the years which were occupied in preliminary studies, the chief engineer, M. Gerwig, had omitted to gauge in winter the volume of water carried down by the Tremola and the Tessin, the only torrents which flowed in the neighborhood of the opening of the tunnel, contenting himself with adopting the figures that had been previously indicated, and which assigned 110 gallons per second as the probable minimum or average of the Tremola torrent. M. Favre and his council of engineers could not wait until the end of the winter to verify this figure, as they had to order the hydraulic motors according to the volume indicated as the probable minimum.

In fact, during the winter months, since the erection of the turbines, the quantity of water of the Tremola has been reduced during several months to between 11 and 22 gallons per second, so that there percolated through the top or sides of the tunnel four or five times the quantity of water that flowed in the bed of the Tremola.

After two years' experience, the contractor had to effect, at a great expense, the turning of the waters of the Tessin by suspending a large conduit against the perpendicular walls formed of unconformable rocks at a height of from 200 ft. to 330 ft. above the bed of the Tessin. These abrupt slopes are subject every winter to the invasion of avalanches, which tear away a portion of the sides or abutments of the aqueduct; during four years nineteen of these avalanches fell, which more or less damaged the canal, and caused interruptions which acted very prejudicially upon the progress of the excavation and to the ventilation of the tunnel.

Finally, during the severe winters that have been experienced, the whole of the waters of the Tessin and of the Tremola proved to be far from being sufficient, and from the end of October last up to the present time more than half of the turbines and air compressors, which the author had erected, have been stopped for want of water; and the result has been an elevation of temperature which proved highly detrimental to the workmen and to the beasts employed for traction in the most advanced parts of the tunnel, and gave rise to serious delays in the progress of the southern gallery.

The foregoing brief analysis will suffice to show the magnitude of the difficulties which M. Favre and his engineers have had to overcome; and it will also demonstrate the intelligence and perseverance that have presided over this great work, and the result of the completion of the two headway galleries within the short period of seven years and five months will be better appreciated.

It is a remarkable circumstance that, contrary to the anticipations of the company's second engineer, the author's system of compressors erected at both ends of the tunnel proved sufficient for the ventilation of the tunnel until the completion of the piercing. Aspiration bells, similar to those used at Mont Cenis, which M. Helwagg had ordered to be erected at both ends of the tunnel, have been of no use up to the present time, and will probably not be called into requisition during the completion of the tunnel.

The junction of the two galleries has demonstrated the correctness of the alignment of the two axes; the difference of level being found not to exceed 4 in., while the lateral deviation was under 8 in.

The total length of the tunnel, measured inside, is shorter by 8¾ yards than the length calculated geometrically.

Happily, the head miner on the southern side had a horizontal boring made, nearly 10 ft. in length, and when the northern gallery had been reached, he had the work stopped on the Goeschenen side; then, by working to a moderate depth, he reduced the partition to a thickness of about 4½ feet.

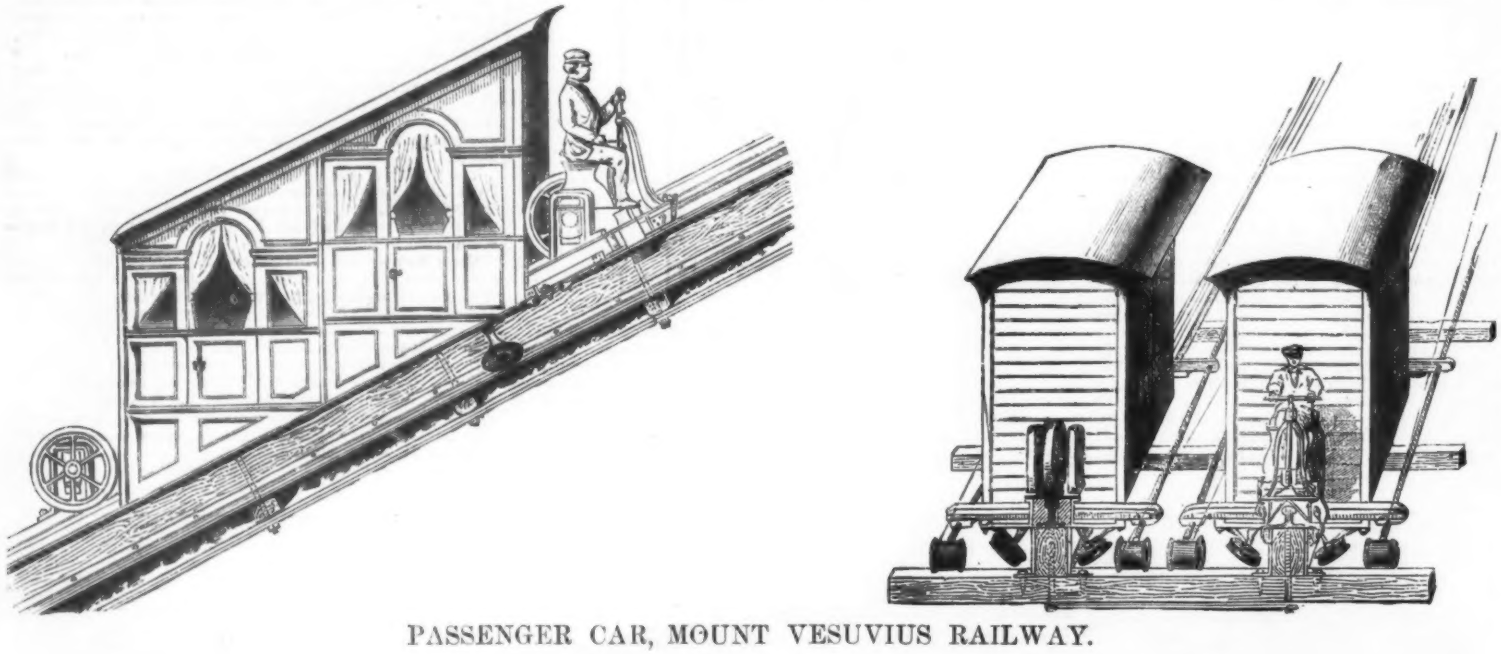
A central cutting was then prepared, consisting of four central and eleven other holes, regularly spaced at short distances around the latter; and the final blast produced a funnel-shaped opening, having a minimum diameter of about 2 ft. 7½ in., and by this opening the engineers present and the foremen were enabled to pass immediately from one gallery into the other.

It was on Sunday, the 29th of February, that the communication was effected between the two galleries. At that time the barometer at Goeschenen, at the northern end of the tunnel, stood 16 in. higher than at Airolo, at the southern end. A current of air was immediately established through the gallery, its speed near the opening being 49 feet per second. A few hours later the barometer had fallen at Goeschenen, and the height of the mercurial column at Airolo was 0·04 in. higher than at Goeschenen; it was evident, therefore, that the current had changed its direction, and now proceeded from south to north, but its speed was only about 13 in. per second.

These interesting experiments will be continued, the results of which will furnish comparative tables for discussion when the principal data shall have been received.

The piercing of the longest tunnel in the world has been accomplished in seven years and five months, the rapidity of its execution being unprecedented in works of this kind; for, relatively to its length, the St. Gothard has been bored in one fourth of the time which was occupied in the boring of the Hanenstein Tunnel, and in less than half the time taken to pierce the Mont Cenis. The great advance in the art of tunnel driving is due to the improvements in the boring machinery and other appliances, and especially to the efficiency of the air-compressors, invented by Professor Colladon.

Nothing was wanting to complete the satisfaction of the engineers and others connected with the undertaking but the presence of M. Favre, the contractor, who, it will be remembered, died six months ago in the tunnel which he had so nearly brought to a successful conclusion, and with which his name will ever be associated.



PASSENGER CAR, MOUNT VESUVIUS RAILWAY.

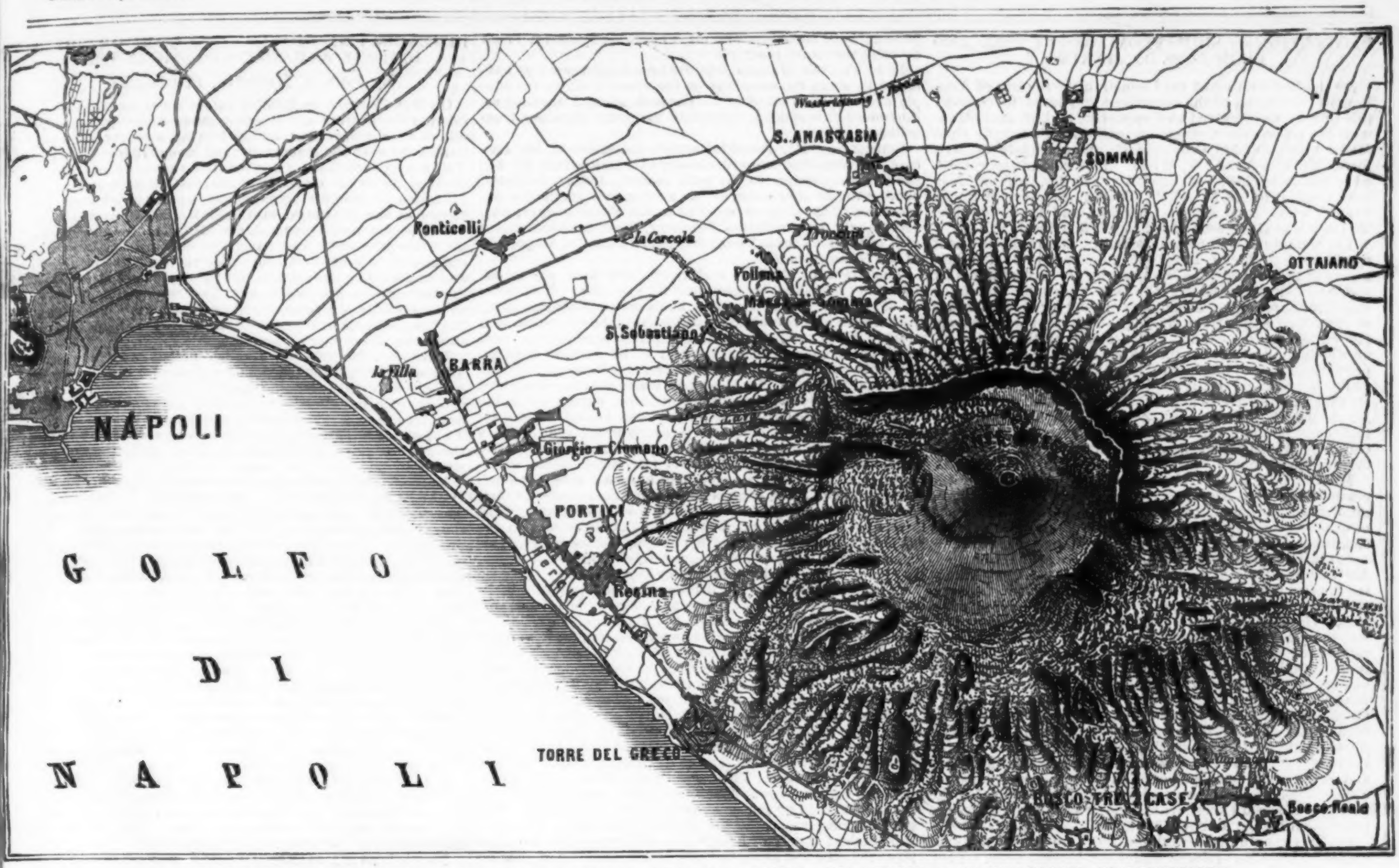
THE ST GOTHARD TUNNEL.

THE Geneva correspondent of the *Times* writes, under date April 5:

"M. Stapff, a scientific member of the St. Gothard engineering staff, writes to the *Journal de Génève* to correct certain theories touching the variations of the air currents in the great tunnel and their causes, which have recently been going the round of the continental press. The direction of the current through the tunnel, he says, of which the south portal is thirty-six meters higher than the north portal, is determined by two causes. The first is the difference between the weight of the column of air thirty-six feet high, at the temperature of the interior, and the weight of a similar column at the temperature of the outside of the tunnel. If the outside temperature were always lower than that of the inside, if there were no points of resistance—if the barometric pressure were always equal on both sides of the mountain—then the draught would always tend from north to south.

"The second cause is the difference of the barometric pressure on the two slopes of the mountain. If the barometer be higher on the north than the south, the current will be from north to south, and *vice versa*. Thus the barometric pressures may increase, or neutralize, or diminish the current determined by the first cause. The most essential 'resistances' that modify the full effect of these two forces are (1) the counter-pressure of the air, which in passing through the tunnel is heated and expanded; (2) the friction of the rocks and other fixed objects. These four factors (and a few others of minor importance), taken together, determine the direction and the speed of the current during a given period. All are variable, even the resistance opposed by the friction of fixed objects.

"In order to ascertain the relation to each other of these four variable conditions and the draught, it was necessary to make a series of direct observations in different circumstances. The meteorological observations which have been regularly made during the construction of the tunnel at Airolo and Goeschenen furnish the statistics necessary to find out the number of days (in a month or a year) during which a current from north to south or a complete calm may be expected to prevail; and the calculation of probabilities made on this basis will be utilized in the contemplated ar-



MAP SHOWING THE NEW RAILWAY UP TO THE CRATER OF MOUNT VESUVIUS.

rangements for the ventilation of the completed tunnel. M. Stapff then goes on to say that he has been occupied in studying the phenomena connected with the movements of the air in the tunnel for a considerable time; and that he made many observations on the day of the opening, February 29, a full account of which he has transmitted to the headquarters of the St. Gothard Railway and Central Meteorological Bureau at Zurich.

"He says further, that on the day in question the barometer was higher at Goeschenen than at Airolo, the draught from north to south, and that in the little gallery (that on the Airolo side) the current immediately before the finish was at the rate of 0·15 meter per second. After the joining of the two galleries, the current between 1 and 1:15 P.M. was at the rate per second of 0·24 meter; between 1:45 and 2, 0·53 meter; between 2 and 2:30, 1·2 meters; at 3:20, 1·6 meters; 4:25, 0·91 meter; 4:55, 0·46 meter; 5:20, 0·0 meter; at 5:25 the draught, at the rate of 0·27 meter, was from south to north; and at 6 o'clock it was still from south to north. During this time the barometer at Goeschenen had fallen, and that at Airolo had risen. At 6 o'clock the observations which were made at Goeschenen, at a point 3,000 meters, and at Airolo at a point 2,070·5 meters above the level of the sea, were discontinued."

THE CARRIAGE ROAD AND RAILWAY, MOUNT VESUVIUS.

PROTECTION OF SHIPS FROM LOSS BY FIRE AND FROM LOSS BY SINKING.

At the last meeting of the Council of the Society of Arts, London, the report of the committee appointed to consider this subject was received and approved, and, in accordance with the report, the Council awarded the Fothergill Gold Medal to Mr. Donald Currie, M.P., and a Society of Arts Silver Medal to Mr. J. W. Wood. This committee consisted of the following: Admiral A. P. Ryder, Admiral Nolloth, Capt. Price, R.N., M.P., Thomas Brassey, M.P., B. Francis Cobb, Lord Alfred Churchill, and Capt. Toynbee. To these was afterwards added C. W. Merrifield, F.R.S.

The committee held several meetings, and resolved that it would be desirable to offer one gold medal for the best means of preserving ships from loss by fire and from loss by sinking; a silver medal for the best means of protecting ships from fire; and a second silver medal for the best means of protecting ships from sinking. This proposal was approved by the Council, and a programme of the conditions on which applications for the medals might be made was approved and issued, the date up to which models or drawings could be received being fixed at the 1st January, 1880. By that date thirty-two applicants had sent in their claims for the medals. The committee held several meetings for their consideration, and came to the decision that the application by Mr. Donald Currie was certainly the one which deserved most regard.

Mr. Donald Currie's claims, unlike those of most of the competitors, were based, not on any specific invention or appliance to be employed on ship-board, but on the method of construction he had adopted in his well known ships and steamers, and specially in his mail steam packets, voyaging between London and the Cape. In his letter of application, Mr. Currie submitted for the consideration of the committee the two most recent of his fleet of Cape mail steamers, the Kinfauns Castle and the Grantully Castle, each of 3,600 tons. He stated that in no service, even in the Royal navy, was there more careful regard to safety of life in the perfection of construction in vessels than in the ships above mentioned, combining suitability for their trade and the largest amount of immunity from danger to life and property. Both vessels named were built on the Clyde; the Grantully Castle, by Messrs. Barclay, Curle & Company, and the Kinfauns Castle, by Messrs. John Elder & Company. The Kinfauns Castle is of steel, the first ocean mail steamer built of that material. The two vessels are of the same dimensions and of the same horse power. They were constructed of different materials, and on somewhat different lines, for the purposes of speed experiments. Their peculiar features are thus stated by Mr. Donald Currie:

1st. In strength and scantlings they are considerably in excess of Lloyd's requirements for the highest class. They have each three steel or three iron decks; the frames are all carried up to the upper deck; the upper deck is planked with teak, the main deck with pitch pine, the third deck partly with pine. In each vessel there is a fourth iron deck in certain of the compartments covering the water tanks about four feet high.

2d. Each water tank serves the double purpose of regulating the trim of the vessel for speed and seaworthiness after coal is consumed, and of providing for the ship's safety in event of striking rocks or sunken wreck.

3d. In no other ship is there a more perfect—indeed, I might say so perfect—an arrangement of bulkheads; for, in addition to the ordinary bulkheads required by Lloyd's, and suitable for passenger ships, we have water tight and fireproof bulkheads extending from the bottom of the ship to the *upper* deck at the forward and after sides of the engine room, and in the forward and the after cabin divisions of the ships. By these arrangements fire or water cannot extend beyond the compartment in danger; and for the case of fire we have pumping arrangements for each hold, so that, as in the case of the Windsor Castle, which was on fire in the fore hold, we can fill the hold with water. In the event of collision or striking the ground the vessel can float, although a compartment be filled with water.

4th. With respect to risk from sinking, the power of pumping in these vessels is very great, as in addition to the ordinary circulating pumps, we have Gwynne's pumping appliances, capable of throwing out 3,500 gallons of water per minute through a height of 35 feet. Among other advantages incidental to the use of the pumps, I may include the gain from being able to stop or start instantaneously this pump, independent of the main engines. The quantity of water passing through can be regulated with the greatest nicety, and the condenser kept at an even temperature. The circulating pump can be applied to empty the bilge and the water ballast while still continuing to pump through the condenser, which is very valuable in case of leakage. A peculiar feature of this pump arrangement is, that the engine is placed high up in the engine room, so as to be able to work independently of the main engine in the event of the fires being put out, and the ship forced to make use of her pumping arrangements in order to be kept afloat.

5th. If one of these ships should run ashore, the boat and life buoy arrangements are especially fitted for saving life.

6th. In maneuvering at sea to avoid collision, or in entering ports, to prevent risks such as are common in the Thames, the form of the ship's bow and the adaptation of steam steering gear, enable us to secure the most rapid maneuvering possible.

7th. The mercantile marine in event of war will have an important part to play in national defense, and, with the approval of the Admiralty, these ships are adapted to act as cruisers. The bulkhead arrangements and strength in beams and stringers are sufficient to enable the vessels, without straining, to carry heavy guns; while the equilibrium so desirable between speed and economy has been fully secured. These vessels might run from England to Japan, *via* the Cape of Good Hope, without purchasing a ton of coal, and this at full speed, carrying not only sufficient coals with a good surplus on arrival, but having capacity for a battalion of soldiers with stores and baggage.

8th. In estimating the equilibrium referred to, the cost in coal is often overlooked, and as this cost implies space occupied and time lost by variation in draught through consumption, your committee can easily estimate how nearly we have been able to approach the purpose aimed at, when I tell you that 40 tons of coal per day would take this vessel on her cruise at about 12 knots an hour fully laden; and in the Cape trade such a vessel as the Kinfauns Castle can carry sufficient coal from London for a voyage to the Cape and back again without the necessity for purchasing abroad, and with capacity for 300 passengers and about 1,800 tons cargo.

9th. There are details which I need not specify, but I may mention we have been among the first to use Sir William Thomson's compasses, also his sounding machine. The steering is by steam, and there are reserve hand-steering apparatus, both amidships and aft, to provide against a break down of the steam gear.

10th. The risk of damage to fire hose is prevented by having pipes along the waterway on the upper deck for the supply of water in event of fire. The look-out and signaling arrangements are specially complete to secure freedom from collision.

Considering Mr. Donald Currie's statement of his own case, the committee were decidedly of opinion that he had shown strong claims to the gold medal. Before, however, coming to any conclusion on the matter, they resolved to inspect one of the ships referred to in Mr. Currie's letter, and, accordingly, on the 10th of February, the committee paid a visit to the East India Docks and made a careful inspection of the Grantully Castle.

The Grantully Castle is a ship of 3,600 tons; she is 360 feet in length, 43 in breadth, and 32 in depth. Her decks are all of iron, the upper, main, and lower deck beams being plated with iron seven-sixteenths to five-sixteenths of an inch thick. There are fireproof bulkheads one-quarter inch thick at the ends of the engine and boiler casings, between the second and third class passengers, and between the third class and the crew. By these bulkheads the ship is divided into seven fireproof compartments, each capable of being entirely separated from the rest of the vessel. The after orlop deck is of iron and made perfectly water-tight, with an independent hatch to the main deck, so that the lower after hold and the after orlop hold form two independent water-tight compartments. In each hold holes are fitted through the main deck for passing a hose through in case of fire, these holes being filled up with iron and wood plugs. The water ballast tanks form practically a double bottom to the ship for nearly two-thirds of her length. Between the engine room and the boilers there is a water-tight bulkhead which, in case of need, can be immediately closed.

The donkey engine for driving the feed pumps can be worked from a separate boiler at a higher level than the ship's boilers, so that in case of the furnaces being flooded steam could still be supplied to work the pumps, which can be adapted to discharge either on deck or overboard, and to draw from the sea or the bilge. The donkey engine itself could be readily worked, even though the engine room were flooded above the level of the pumps. There are two reciprocating pumps, one seven-inch Downton pump, one deck hand bilge pump to each compartment, two feed and two bilge pumps, one hand pump arranged to draw from the sea, the bilge, or the hot-well, and to discharge to the boiler, on deck, and overboard. These can, if necessary, be connected with the main engines. The fresh water condenser pumps can also be used to pump from the bilge overboard. The special arrangements for fire are very complete. There is an abundant supply of hose, but in addition to this fixed fire pipes are attached along the side of the vessel, and connection can be made to these at any point required. There are eight boats, all fitted with patent lowering gear.

The arrangements as regards drill in case of a fire or accident appear to be of the completest and most efficient character, and the committee are informed that these arrangements, as well as the appliances of Mr Currie's ships themselves, have been fully tested by accidents which have happened to the Windsor Castle, and to others of his fleet of steam packets. When the Windsor Castle was on fire in the fore hold, that part of the ship was isolated from the rest and filled with water. In this condition the ship was enabled to return to London.

Besides having examined the vessel itself, the committee made a careful inspection of the drawings of the ship, which, with the specification, were submitted for the purpose by Mr. Currie, and finally they arrived at the conclusion that Mr. Currie's ships showed a marked advance in the direction of preventing loss of life at sea by fire or wreck, and that the attempts which he had made, and the success he had secured in practical arrangements, fully deserved to be recognized by the award of the Society of Arts gold medal. In making this recommendation the committee bore in mind that they had not formally before them the ships of other companies than those of Messrs. Donald Currie & Co., many of which, they are aware, are of great excellence and of high merit. None, however, of these competed for the medal, and they consequently did not feel it their duty to institute a comparison between them and Mr. Currie's ships.

Having thus decided on their recommendation as to the award of the gold medal, the committee considered whether any of the applications before them deserved recognition by the award of a silver medal. As regards methods of protecting ships from fire, the committee do not consider that their merit in the case of well known inventions, or their novelty in the case of those which were fresh and untried, was such as to require any award. In respect of inventions for protecting ships from loss by accident, they decided to recommend for the award of a silver medal the very ingenious leak stopper of Mr. J. W. Wood, which has on numerous occasions proved of great value, and is coming into extensive use, especially in the merchant service. Its principle is tolerably well known. It consists of an iron toggle, by means of which a plate of iron varying in size from a few inches to some three feet, can be bolted over a hole in the side of a ship. This toggle consists of a pair of iron bars hinged together. One of these bars is slotted out for about half its length, and the other bar is jointed thereto in such a manner that it can rest within the slot for part of its length, both bars being then in the same line, so that the whole of the slotted bar, and part of the other, can be thrust through the hole in the ship's side. As soon as the slotted bar is free of the hole, it overbalances, and its heavier end swings down, thus forming a T, the cross bar of which is outside the side of the vessel, while the stem passes through the hole. This stem is screwed and has nuts on it, by which the plate is held fast. A pad of felt is placed between the plate and the side of the vessel, so that when the whole is screwed up the felt fits over any jagged edges of the hole, and causes the plate to fit more or less water-tight against the side. The committee have had before them evidence of the practical value of the invention, and of its having actually proved of service in many cases of accident.

New Chemical Photometer.—The author recommends a mixture of mercuric chloride with neutral ammonium oxalate. The photometer is filled with two volumes of a solution of forty grammes ammonium oxalate in one liter water mixed with one volume of a solution of fifty grammes sublimate in one liter of water. Before use it is exposed to light till the deposit of mercurous chloride begins to occasion a turbidity, and is then filtered. The mixture can be kept without change in the dark. Light which has passed through red, yellow, or yellowish green glass is inactive, and the decomposition is mainly produced by the ultraviolet rays.—*J. M. Eder.*

REGENERATIVE STOVES—A SKETCH OF THEIR HISTORY AND NOTES ON THEIR USE.*

By John N. Hartman, Philadelphia.

On May 19, 1857, an English patent was granted to E. A. Cowper for heating air or other gases under pressure by means of a regenerator inclosed in an air tight iron case, having between the regenerator and case a lining of brick. This patent provided for heating the stoves by a separate fireplace, or by gas direct from the blast furnace. A number of forms of interior arrangement of the brickwork are shown in the drawings; also hollow poppet valves with hollow stems, and a pipe inside of the stem for circulating the water; the valve seats have coils cast in them for water circulation to keep them cool; slide valves, with snake coils cast in the disks, are shown, and the use of cold air for cooling the valves is also described. The combustion chamber of these stoves was central, and openings were provided at the top and bottom to get into the stoves. These Cowper stoves are all circular in section.

November 10, 1865, an English patent was granted to Thomas Whitwell for regenerative stoves for heating air or gas, provided with cleaning openings at the top and bottom capable of being closed with firebrick plugs and doors. The drawings show a rectangular stove inclosed in an iron case. The interior brickwork has numerous up and down passages through the stove, but there is no claim on the interior construction.

March 3, 1868, an English patent was granted to Charles Cochrane for a slide valve to be subjected to high heats. The disk of this valve was hollow, and had a circulation of water through it by the two hollow stems that operated it. The valve seat was detachable and had a coil cast in it, through which water circulated. The valve and seat were placed on an incline to the body to cause the valve disk to lie on the valve seat. A cap was placed on the bottom of the body to get at the interior readily.

January 5, 1870, an English patent was granted to Siemens, Cowper, and Cochrane, for the construction of regenerators in fire brick stoves, with numerous vertical passages of sufficient size to allow a brush to pass through and clean them. These passages had slight projections on the sides to turn the air over and over as it passed through. A claim also covered the use of horizontal passages connected at each end alternately, and the use of blasts, or jets of air, or steam to clean the stoves. This patent was taken out in this country.

July 8, 1871, an English patent was granted to Thomas Whitwell for a cup under the poppet valves of regenerative stoves to catch the mud deposited in the valve by the water, and keep it away from the valve face. This patent was taken out in this country.

March 23, 1872, an English patent was granted to E. A. Cowper for arranging the regenerators of firebrick stoves, whereby the flame passed up and down through the regenerators a number of times. The area of the first passage is large, and that of the subsequent passages smaller, the surface being increased by placing more openings of the same size in the passage. The larger area permits more complete combustion, and the smaller areas provide increased surface to take up the heat. By this arrangement the gas or air passed in the same direction along two or more adjacent walls or partitions. This patent is now being taken out in this country.

August 27, 1872, an English patent was granted to Thomas Whitwell for upright regenerator walls stayed by cross walls and with cleaning doors on the top and underneath the stove. The air for the combustion of the gas was also heated by passing it through the hollow walls of the regenerator. This patent was taken out in this country.

May 8, 1874, an English patent was granted to Cochrane and Cowper for the construction of a cylindrical regenerative stove, with an ascending circular flue or combustion chamber near to one side of the interior of the stove, in combination with a regenerator occupying the remainder of the interior of the stove. The flue and regenerator are so placed that the distances traversed by the air or gas are equal, or nearly so. The apertures of the regenerator passages at the top are narrowed to equalize the distribution of the air or gas. This patent was taken out in this country.

May 16, 1876, an English provisional patent was granted to Thomas Whitwell for regenerative stoves, with walls or partitions so arranged as to divide the current of air and cause it to pass in the same direction along two or more adjacent walls or partitions. Also for the use of cast iron pipe on the chimney side of the stove to take up the heat lost at the chimney. This patent was taken out in this country, but the cast iron pipe is omitted in the American patent. When the provisional patent expired, the patent of E. A. Cowper, of March 23, 1872, prevented a full patent being issued in England.

October 2, 1877, an American patent was granted to Thomas Whitwell for a water cooled slide valve, with a detachable valve seat having a coil cast in it. The valve disk has also a coil cast in it, and the valve face is placed at an angle to the body to cause the valve to lie on the face. The Siemens-Cowper-Cochrane stove is the result of the combined learning, inventive talent, and practical knowledge of the three men whose names it bears.

Dr. Siemens, the physicist, the originator of the regenerative system of heating, is well known to you all; Mr. Cowper is a fertile inventor in many fields, his last notable invention being the transmission of handwriting by telegraphy; Mr. Cochrane comes of a race of ironmasters, and is well known by his able articles on the iron manufacture in English technical journals. The patents recently granted and now pending in connection with the Siemens Cowper-Cochrane stoves are improvements in slide valves and the use of compound nozzles to decrease the number of attachments to the stoves; the use of interlocking regenerative brick, and the utilization of the waste tuyere water to wash the gas; improvements in gas washing and the use of overhead flues with cleaning doors; the use of piston surging valves for cleaning the stoves, and improvements in the pipe conveying the hot blast to the furnace, and finally the use of an equilibrium valve worked by a clock attachment to equalize the temperature of the blast during a blow. The first Cowper stoves could not be cleaned on account of the brick of the regenerator being laid with interstices between them, but with no continuous passage from top to bottom. The stoves worked well when new.

The next step was to keep the dust out of the stoves by using large settling chambers containing shelves for catching the gas dust. This helped the stove, but the chambers made additional expense, and they have since been abandoned. The next improvement consisted in making numer-

* Read at the Pittsburg meeting of the American Institute of Mining Engineers, May, 1879.

ous vertical passages with thin walls in the regenerator, which could be cleaned with a brush, or by jets of air or steam. Still later, the vertical combustion chamber was placed on one side of the regenerator, causing the gas and air to travel the same distance in the stove. The diameter of the stove was diminished and the height increased, which cheapened the stove and gave a better distribution of gas or air over the whole surface of the regenerator.

Mr. Whitwell bought of Mr. Cowper the right to build regenerators inclosed in air tight casings, and being convinced that his rectangular stoves would bulge out, altered them to the circular—Cowper—form. He also bought of Dr. Siemens the right to use the brick for regenerative purposes, and brought his stoves into practical operation. Finding the escaping gas in the chimney too high in temperature, Mr. Whitwell placed a number of large iron plates in the back courses of his stoves for the purpose of taking up the waste heat, but after trial they were abandoned. He next placed a series of cast iron pipes in the back courses of the stove. This involved a separate set of pipes and valves, and was found too cumbersome. Mr. Whitwell found it impossible to collect this heat without greatly increasing the size of his stove.

It is here that the advantages of the regenerator with thin walls and large surface is shown, since the lower the temperature the greater must be the surface to take up the heat. The Siemens-Cowper-Cochrane stove consists of an air-tight iron shell lined with red brick and fire brick, containing a flame flue near one side, which is partly surrounded by a regenerator. The gas is burned in the flame flue or combustion chamber, and the products of combustion are then spread over the surface of the regenerator, which absorbs the heat, the escaping gas going off at a temperature of 250 deg. Fah. when working with blast heated to 1,200 deg. The regenerator is formed of brick three inches thick, so arranged as to leave numerous holes four inches square from top to bottom, giving an enormous heating surface with a minimum of brick. In experiments made with nine inch walls, the stove was put on a blow for three times in succession without heating it up. After waiting four hours each time, the heat in the interior came out to the surface of the walls, showing that there was a large heat storage that was not available in the two hours the stove was on a blow. If this amount of material had been placed in three inch walls the stove would have had three times as great capacity in the two hours. This enlarged surface would give a more uniform heat and be more economical on gas. If we take a No. 1 fire brick, heat it white hot, and drop it into a cistern of water, it will be found that when it has cooled sufficiently to be taken in the hand it is still white hot half an inch from the surface. This shows the slowness with which fire brick yields up its heat, and as three inch walls during a blow of two hours have proved as efficient as nine inch walls, heavy walls are evidently useless.

A serious defect in fire brick stoves is the glazing of the walls from overheating when the stoves are too small. This glazing prevents heat from being absorbed or given out. This glazing can be overcome by increasing the surface so that the stoves can be worked at a lower temperature and yet keep the required heat of blast. It is a choice between a mass of thick brickwork at a high heat or a large surface at a moderate heat. The first will glaze the walls and give an irregular heat, the second will not glaze and will give a more uniform heat. In calculating the heating surface of fire-brick stoves, only those parts of the walls that do not come into immediate contact with burning gas should be taken as heating surface. Any brickwork exposed to burning gas is invariably glazed when there is perfect combustion, and where gas is burned through the whole length of the stove the efficiency of the stoves is much decreased. The stoves at Crown Point have been subjected to extremely high heats, and after fifteen months' running the combustion chamber was found slightly glazed, just enough to protect the brick, while the regenerator was not at all glazed, the bricks being in the same condition as when first put in.

This superficial glazing of the fire-brick in the combustion chamber is an advantage, for the transmission of the heat is thus hindered, and the total destruction of the bricks prevented. By confining the combustion to one large chamber, as is done in these stoves, and allowing the gas to expand, the temperature of the gas is lowered, while the volume is increased, and glazing in the regenerators prevented. This lower temperature necessitates more surface to take up the heat, which is provided for in the thin walls of these stoves. The capacity of the stoves is measured by the surface of the regenerator alone. Five square feet of regenerator surface is used for each cubic foot of air per minute delivered by the blowing engine. The stoves are so constructed that either the dome or the regenerator or the combustion chamber can be taken out and repaired without interfering with each other, as the heating surface is independent of the roof or side walls.

The old objection to cleaning these stoves no longer exists. With the straight four-inch passages a brush is guided on all four sides, and can be passed through them more rapidly and effectively than in an opening where it is guided on two sides only. Each passage of the brush cleans a space sixteen inches wide, and it takes about thirty seconds to clean an opening. There is one large cap at the top to remove to get at all the openings.

As an ounce of prevention is worth the pound of cure, these stoves are fitted with a plain, simple gas-washer which removes nearly all the dust in the gas. There is a small portion of a white flocculent ash that passes the washer, but it is infusible at the highest heat applied to it, and is easily blown off the walls.

The worst enemy of the fire-brick stove is the fine ore dust that forms an easily fusible silicate of iron which glazes the walls. The gas washer catches this dust and keeps it out of the stove as well as the coal tar when raw coal is used. The coal tar condenses on the valve faces, and prevents the valves from opening or from shutting tight. Above the washer is a dust catcher, which relieves the washer of part of its work. When a furnace works irregularly and slips, large volumes of dust are thrown over, and at such times the dust catcher is especially valuable. After the gas leaves the dust catcher it descends and meets the water spray formed by the waste water of the tuyeres falling in the three-quarter-inch streams on splash plates, breaking up the water into spray, which, falling down through the gas, cools it, and thus tends to draw the gas from the tunnel head. The gas receives a further washing by passing horizontally under the broad flange, after which it slowly ascends through the large annular space, where any entangled moisture may be deposited. Trial was made of dipping the flange below the water, which washed the gas better, but it threw too much back pressure at the tunnel head. To wash gas properly, a large volume of water is necessary. The more water used the better the washing is done, and the water, moreover, is prevented from getting hot enough to form vapor, which would impair the calorific power of the gas. The water used in the washer should escape with not over 30° additional heat. Care must be taken in igniting the washed gas. If the valve is thrown open suddenly, an explosion is sure to follow. The valve must be opened slowly until the first blue point of flame is seen, after which there is no danger. To ignite the gas, a large oil lamp is used with a hollow handle, which keeps the flame supplied with air and prevents the gas putting it out. After passing the washer, the gas possesses a higher calorific power, being freed from the dust which interferes with perfect combustion. Another advantage of washing the gas is found in the fact that dust is not blown into the furnace, where the silica might be reduced if not absorbed by a strongly basic slag.

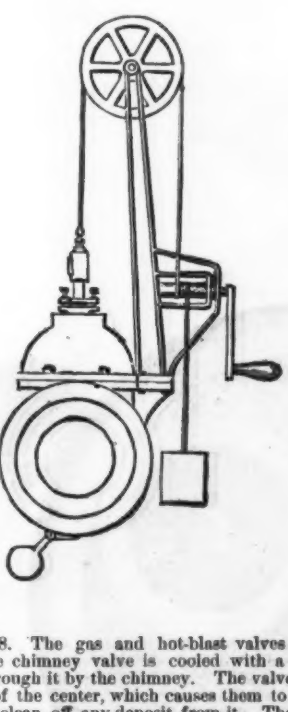
After a fifteen-months' run at Crown Point, the furnace with fire-brick stoves went out of blast with its hearth cut through. A careful examination of the stoves showed there was no dust in the regenerator, each opening being as clean as when started, and there was no dust in the bottom of the stove. This proves that these stoves can be cleaned while running, and that there is no occasion for a ten hours' stop to clean a stove. These stoves had not been entered for cleaning since first starting them. To burn gas thoroughly combustion must take place in a large chamber with thick walls, maintained at a high heat. In these stoves the gas is cut up into strips by passing it through slots in the bottom of the stoves, then mixed with air, and by the time it has traveled forty-five feet to the top of the regenerator it is thoroughly burned. The regenerator is supported on cast-iron gratings, with a space below for draught passage to the chimney and blast passage when the stove is on blast. Ample provision is made in the walls for expansion, and by using an air space between the shell and wall the heat lost through the shell is reduced to a minimum.

Close by the chimney nozzle is a piston blow-off valve to relieve the pressure in the stove when it is to be put on gas. The valve is operated by the blast, so that when the pressure is taken off the piston, the internal pressure in the stove pushes the valve open quickly and lets the blast escape rapidly, which carries out with it any dust that may have fallen to the bottom of the stove as well as the greater part of the dust deposited on the walls when the stove was on gas. As this is repeated every six hours it removes a large amount of dust and helps to maintain the cleanliness and efficiency of the stoves.

The cold-blast valve is a pivot valve that can be thrown open or shut instantly. Twice a week, at casting time, the air valve and cleaning valve are opened, and the engineer is told to run the engine lively and watch her. When pressure is up, the cold-blast valve is suddenly thrown open, allowing the blast to rush through the stove and sweep the dust deposit from the walls. So strong is this current that care has to be taken lest the top course of the regenerator be blown off.

To resume: the use of the gas washer and the piston blow-off valve, and the practice of blowing through the stoves twice a week, prevent accumulation of dust and insure regular working. The patents on these stoves give them the exclusive right of cleaning by this method.

The valves are all plain, simple slide-valves, as in annexed cut, and are modifications of the original Cochrane



valve of 1868. The gas and hot-blast valves are water cooled. The chimney valve is cooled with a current of air drawn through it by the chimney. The valves are hung on one side of the center, which causes them to lie against the face and clean off any deposit from it. The gland has a lateral motion, which prevents the stem from binding. By slacking up the four bolts holding the cap and winding up the chain, the valve and cap can be removed in five minutes. A half-inch stream of water supplies each stove; and, where not over 1,200° of blast is used, the valves can be run without water. To operate these stoves they are opened and gas burned in them four hours, when they are closed and the blast blown through them for two hours. Three hours are required to give the stoves time to heat up. The flues connecting these stoves are all overhead, and can be cleaned at casting time in ten minutes. Owing to the small amount of gas used the flues are small. This is due to pure gas and large heating surface.

On first turning a stove on a blow the temperature of the blast is higher than required, and as the blow continues this temperature falls, and by the end of the blow it is too low. To obviate this and maintain a uniform temperature, a connection is made from the cold-blast to the hot-blast pipe. In this pipe is placed a valve with a clock attachment, to gradually close the valve during two hours. At the beginning of the blow this valve is wide open and admits a certain volume of cold air, which cools down the hot blast to the proper temperature. This cold air does not rob the stove of heat, but simply equalizes the temperature of the blast during the time the stove is in air. The amount of air heated per minute, in a blow of two hours, to a given temperature and the temperature of the escaping gas are the measures of efficiency of fire-brick stoves.

Many attempts and propositions have been made to substitute other material in the regenerator for fire-brick, but without success. The capacity of fire-brick for heat, and its slow conducting power, render it most advantageous for the storage of heat, and hence for uniformity in radiation. Fire-brick stoves cannot be destroyed, and under ordinary circumstances they should run ten years without repairs, except the refitting of the valve faces, which may be necessary every three years. Bricks which have been in use for twenty years in regenerators are found to be still good.

An important feature in fire-brick stoves is their ability to cope with damp weather and yet keep the furnace steady. Moisture entering the furnace is decomposed into oxygen and hydrogen, absorbing heat with rapidity, and giving a cold cinder and cold iron. If the hydrogen was burned in the furnace, we could get these heat units again; but experience shows that it escapes as hydrogen and can be detected at the tunnel head by analysis.

When damp weather comes on it is necessary to use a little more gas to keep the blast heat uniform. As the specific heat of the blast is increased by the moisture, it will absorb more heat units from the regenerator. This extra heat will give to the hearth the heat that the decomposition of the moisture would absorb. It has been found that 1,250° is a good average temperature for safe running when the furnace is properly burdened. This leaves a margin in the stove for safety, and allows enough carbonic oxide in the gas to keep up steam and hot blast. If the heat in the hearth is lost by change of cinder, leaky tuyeres, or poor coal, the heat of the blast can in a short time be run up to 1,700° and the lost heat restored. The intensity of the heat of the hearth is mainly due to the descending stock, which acts as a regenerator, collecting the heat and delivering it in the hearth. Of the total heat of the hearth between sixty and seventy per cent. is due to the heat collected by the stock.

If a furnace scaffolds and hangs, then the stock does not descend, and no heat arrives at the hearth from this source. It is then that one of the great advantages of fire-brick stoves is apparent; for the heat of the blast can be raised to 1,700° or 1,800° and the evil quickly corrected. This is the only efficient way of removing a scaffold. With this reserve in the stoves a furnace is always safe, and it should always be maintained. Running in the old style, with plenty of coal, gave a reserve; but for economical running and fast driving the coal must be reduced to a safe minimum.

The early advocates of the fire-brick stove supposed that each 100° added to the blast would save at least 200 lb. of coal. Although this has been shown to be an error, yet, after careful observation, it has been found safe to assume the saving of coal, containing 95 per cent. of carbon, at 2 cwt., between 913°, the limit of the cast-iron stove, and 1,250°, the average of the fire-brick stove. This saving of 2 cwt. is attended with an increase in yield of iron of 12 per cent., without additional cost of labor. With this saving of coal the stoves will pay for themselves in three years, and leave a surplus for contingencies by the extra amount of iron made.

The arguments which have been brought forward in opposition to the replacement of iron pipe by fire-brick stoves have, we think, been very effectively answered by the general introduction of the latter in all iron-making countries, where they are built with sufficient surface, meet with universal favor for safety, efficiency, and economy. A point raised against these stoves is that gas will not distribute evenly through the whole regenerator. Experience proves this point is in error. By carefully watching the action of the gas through the peep-holes at the top of the stoves, it will be found that the gas is evenly distributed. Heated gas tends to ascend, but the draught of the chimney pulls it down through the regenerator. If one side of the regenerator should get hotter than the opposite side, it will rarefy the gas and check its flow through that part. The gas will then work over toward the colder side of the stove and equalize the temperature.

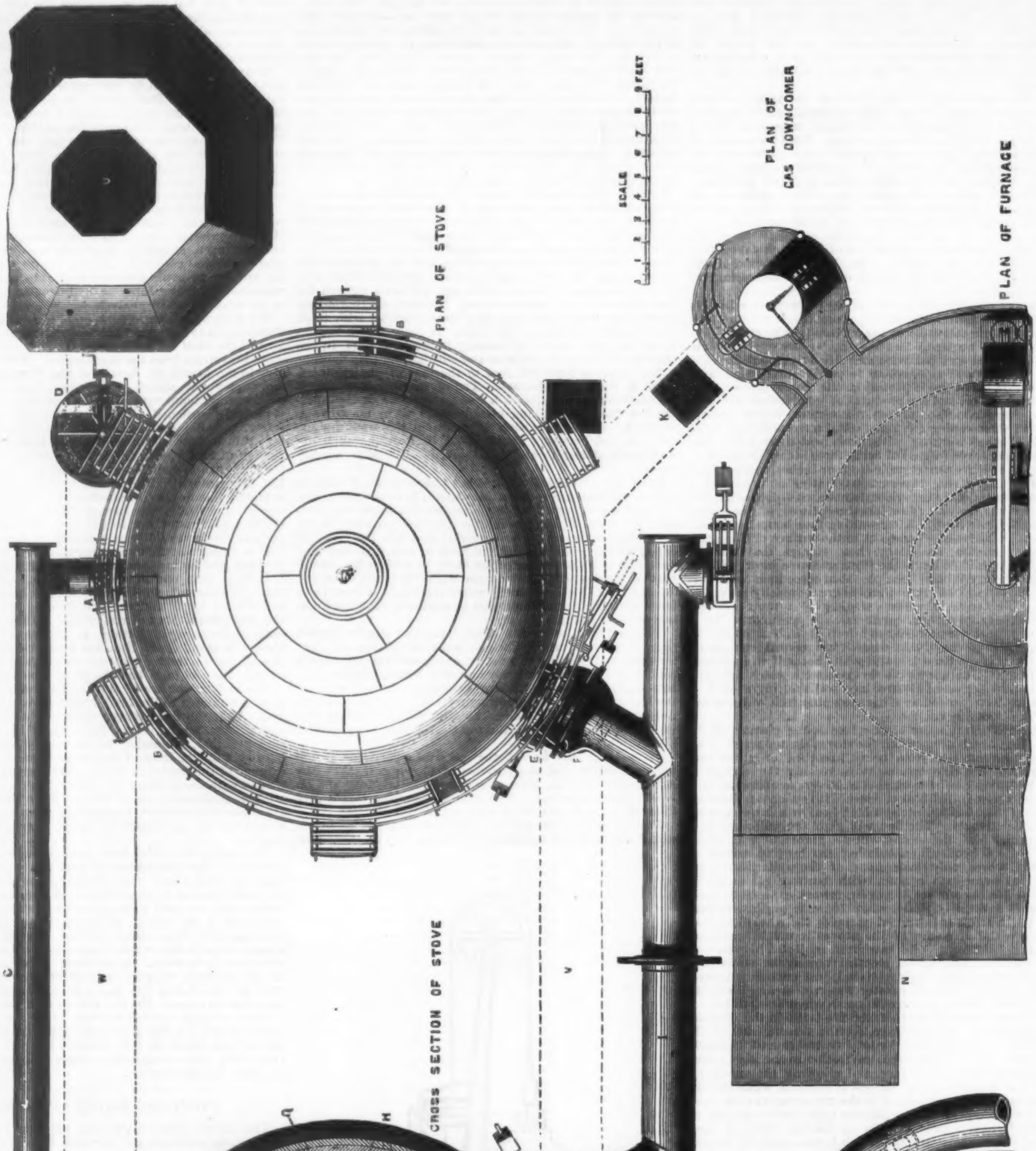
COWPER'S HOT-BLAST STOVES.

THE severe competition that has now existed for some years in the production of pig iron, both in this country and abroad, points naturally to economy of fuel being attended to by the ironmaster, as well as increased power of production from any given plant, whether it be of an old and small type, or of the most modern style of blast furnace of large size, with powerful blowing engines and boilers.

We give on the following pages general drawings of the arrangement of a pair of "Cowper stoves" for blowing a pair of furnaces, and a short description of same, and also add notes of the practical results obtained by the use of the stoves. The stoves are firebrick stoves, with regenerators very like those used in the Siemens furnaces, but are made of such large capacity that they will work well at four-hour shifts and give a very uniform temperature of blast—in fact, more uniform than is commonly obtained from cast-iron pipe stoves. Each stove is alternately heated by the combustion of the waste gas from the top of the blast furnace, and then is made to heat the blast as it enters at the bottom and ascends through the stove. The air-tight casings of the stove are of wrought iron to retain the blast, and are lined with brick to retain the heat.

While heating up the stove the flame passes up the cylindrical flame flue on a compact mass of high temperature, and turns over under the single firebrick covering dome and passes down through the numerous passages of the regenerator firebrick, P, and thus heats it up to a high temperature, the heat gradually penetrating downward as each layer of brickwork becomes fully heated, the heat being stratified—so to speak—from the lower always being the cooler part, so that there is no tendency for the hot and cold air to mix. When the blast is being heated it is brought in at the bottom, and gradually ascends as it becomes heated, so that the very tendency of the apparatus itself it to prevent any cooler air becoming mixed with hotter air, and thus lower the temperature of the issuing hot blast.

The waste gas from the top of the blast furnace is brought down by a peculiar "down-comer," X, which catches a large proportion of the dust that comes over with the gas, the gas passing down a central tube, and then issuing through holes in that tube into an outside tube, while much of the dust goes straight down into a pocket, in which it is caught; the gas descending still lower, again enters the central tube through other holes, while a further portion of fine dust is deposited in a pocket formed by the outside tube;



HOT BLAST STOVES FOR A PAIR OF FURNACES.

DESIGNED BY MR. E. A. COWPER, C.E., WESTMINSTER.

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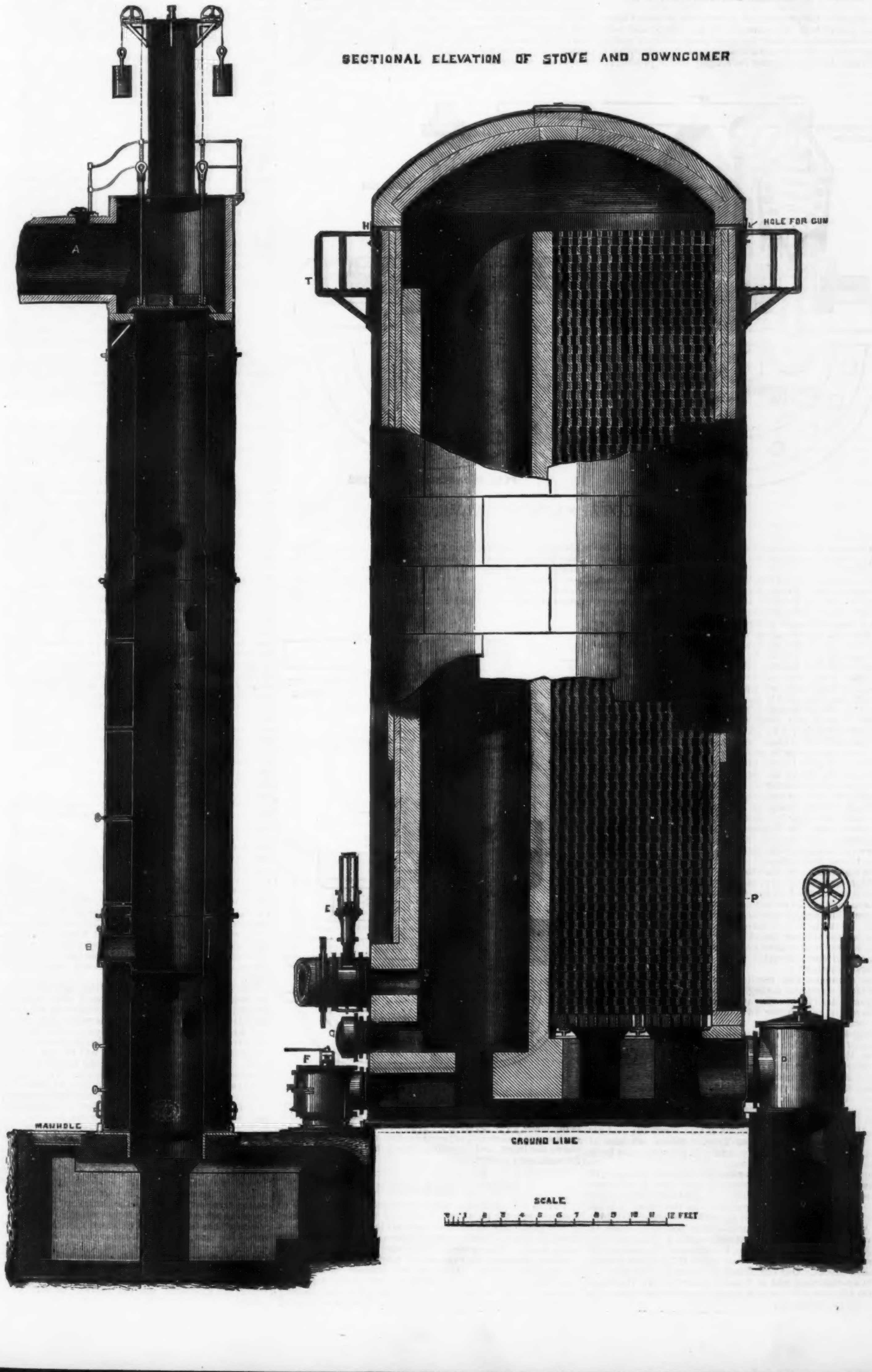


the gas then passes down through an underground flue to the underside of the gas valve, where it enters the stove through a peculiar burner, which allows of three flat sheets of gas passing upward, while atmospheric air is permitted to pass in horizontally between and around these sheets of gas, so that a most intimate mixture rapidly takes place, and thus insures a good full round flame of high temperature being produced in the flame flue, with which to heat the stove.

One result of the products of combustion, or rather flame, being at a very high temperature on ascending, and being cold on descending is, that the stove makes its own natural draught, acting exactly like a siphon, and thus drawing in air and gas and expelling the thoroughly cooled products of combustion at the chimney valve: the friction through the stove is very little indeed—in fact far less than through any other stove.

The cylindrical flame flue is on one side of the stove, and the chimney valve, D, on the other side, so that the distance traveled by the air is nearly the same through any passage, and tiles with definite sized openings in them are placed over every passage to cause perfect distribution. Any light or very fine dust that may settle in the stove is easily blown out at tapping time by arranging a door on the gas valve or manhole, to be opened quickly by two men at a long lever when the stove is full of blast at full pressure—all valves but the cold blast being shut—as then a sudden outburst of compressed air comes out, bringing with it the dust. This is a most efficient plan, and if the dust should hang at all in the stove, it is easily removed by a few slight puffs of gunpowder from a gun once a month; there is no stopping whatever of the stoves for cleaning, and stoves have run for two years perfectly without being opened, and, when opened, have been found to be in perfect condition.

There is, it would seem, little or no wear and tear in the stoves, as the bricks are unaffected after being used for many years, and the wrought-iron casings never want a rivet touching, as they are not subjected to any great heat, being protected by the lining of the brickwork. Many stoves have been put up, viz., about 130, and have been at work for some years in England, Wales, France, Germany, Switzerland, and America, and very many more are now being erected, twenty-nine blast furnaces having been licensed in the United States alone.

The stoves heat the blast to 1,500° Fah., and the effect of this high temperature is to save very largely in the quantity of coke or coal used in the furnace. This saving reaches as much as 20 to 25 per cent. per ton of iron made, and at the same time greatly increases the make of a furnace. The quality of the iron, it is stated, is somewhat improved, and there is less sulphur found in it, owing to less coke being used, and the iron is more gray as a rule. The stoves can be made of any reasonable size, as the bricks stand fairly one upon another.

One advantage that results from the temperature of the blast being so regular during the time of heating is that one stove only need be blowing at a time, and therefore one pair of stoves is enough for two furnaces, and at the present time two stoves are blowing two Staffordshire furnaces and making 465 tons of iron per week, and saving between 7 and 8 cwt. of coke per ton of iron made.

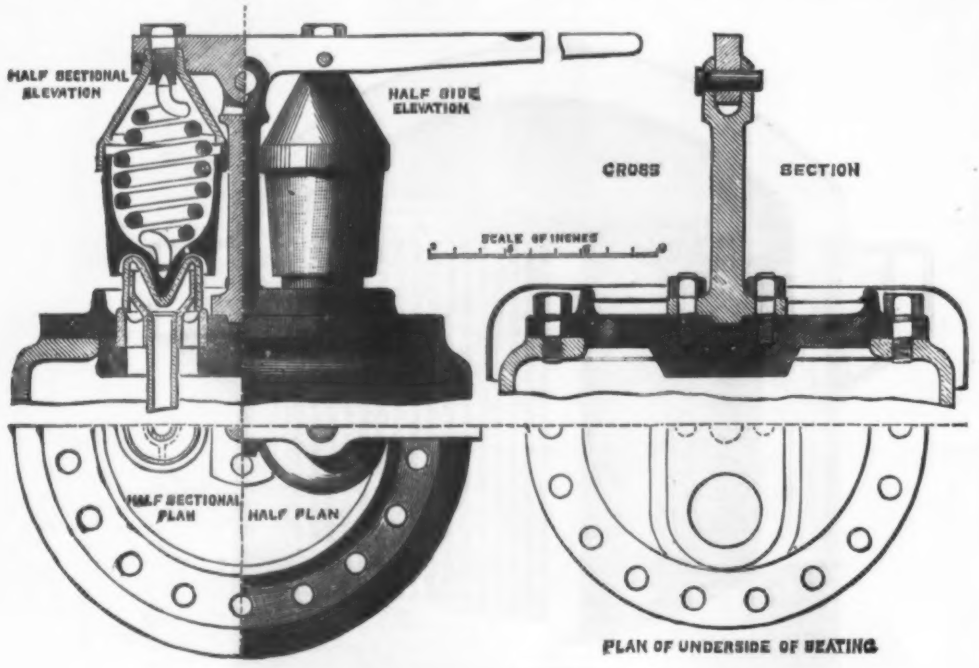
The Edgar Thomson furnace in America is making considerably over 600 tons per week with these stoves. In some cases the economy effected by the use of the stoves during the last few years has made just the difference between making or losing money. Among the firms using these stoves may be mentioned the Tredegar Company, the West Yorkshire Iron and Coal Company, James Bain & Co., Harrington; Sir John Brown & Co., Sheffield; and Sir W. Armstrong, Newcastle-on-Tyne. Stoves are also at work in France and Germany, and will probably soon be in blast in Russia and even China.

In our engravings A is the gas flue from the furnace; B, manhole for cleaning out dust; V, gas flue; E, hot-blast valve; G, air valve; F, gas valve; S, sight hole; D, chimney valve; V, chimney flue; T, gallery. In the plans A is the cold-blast valve; B, manhole; C, cold-blast main; D, chimney valve; O, flame flue, H, gun-hole at bottom of stove; G, air valve; F, gas valve; E, hot-blast valve; K, cleaning hole; V, gas flue; I, hot-blast main; U, chimney; T, gallery; N, lift; L, crescent pipe; M, tuyere pipe; R, cast-iron grating to carry bricks. Our engravings are from the *Engineer*.

On another page will be found a paper, by Mr. Hartman, on the Cowper stove, which details the experience had with it in the United States.

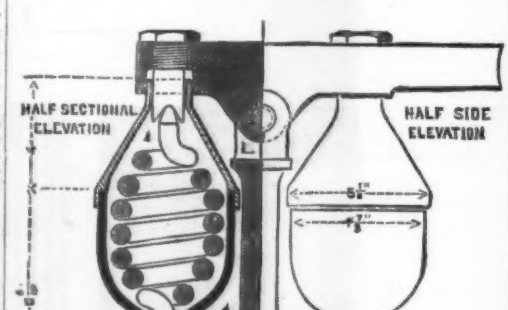
WILSON'S LOCK-UP SAFETY VALVE.

THIS is an improvement by J. C. Wilson, C.E., Westminster, on Klotz's safety valves. The arrangement, as will be observed, constitutes a complete lock-up safety valve. The springs are not accessible for any purpose, nor can their casings be wedged down so as to put any additional pressure on the valves without taking the whole to pieces. The arrangement is applicable to any description of valve, but the Klotz construction is preferred to any other, because the full pressure of the steam within the boiler is always kept on the rising portion of the valve, as distinguished from the reduced pressure on the ordinary form of valve at the time of the escape of steam from under it. The two parts of the



WILSON'S (KLOTZ) SAFETY VALVE.

valve are made of the same metal—gun metal—and are thus quite free to expand, the danger of sticking fast being thus reduced to a minimum. By the use of this valve, it has been found that the pressure of the steam within the boiler cannot be much increased by any forcing of the fire. By means of the trying handle the engine driver can readily



ascertain if the valves are in working order. A considerable number of these valves is now in use, and a number is being made with the body of wrought iron for locomotive engines for Indian railways. The first of our illustrations shows the latter, and the other shows the former, intended for stationary boilers.

WORKING LOW-GRADE ORES.

THERE is considerable talk here on the Comstock now of commencing the reduction of some of the millions of tons of low grade ores which have been left in the vein at various levels nearer the surface than where explorations are now being made. Mining men say this can be done and a profit realized, provided the expenses of mining and milling can be reduced a little. They do not propose to raise any opposition to the miners' union, as they know very well that no country can be truly prosperous unless the laboring classes are well paid for their services. The plan talked of is to allow the miners' union to continue the control of all men put into the upper workings, but that these men shall be allowed to labor where the mines are cool and above a certain level at a certain reduction from $4 per day. This would still leave the control of everything in the hands of the unions, because their own men would, of course, report at once any violation of the agreement looking toward a reduction of wages generally in the mines. This, it is thought, will entirely do away with the "entering wedge" argument, and show that the mining men of the Comstock have no disposition to reduce the wages of those who go into the heat of the mines and do the work in the lower levels.

Conversations have been held with many of the biggest mining men of the Comstock, and all agree that the man who endures the heat and dangers of the lower levels and works there is fully entitled to his $4 per day, and that $4 is none too much. If, however, men could, under these restrictions, be allowed to work above in the manner prescribed, and with no danger to the unions and to the general prosperity of the Comstock, a new industry would no doubt be inaugurated in the mining and milling of low-grade ores.

It might, however, be also necessary that wood and other supplies should be obtained at lower rates in order to make the industry remunerative. It does not seem to be a proposition that the workingmen of the Comstock should make all the sacrifices necessary to inaugurate this work. Wood can be had in abundance at Truckee for $3 per cord. It should be delivered to the mines for less than the $10 now paid. Let the railroad yield a little as well as the laborers, and thus come in for a fair share of the credit of opening a new field of labor and promoting the general prosperity of this section.

If the foregoing plan of co-operation can be agreed upon, there is but little doubt that the work will be commenced. Then, if it costs $1,000 to take out $1,000, the country is a thousand dollars richer, for that amount will have been added to the gold and silver in existence, and men will be given something to do, a consideration of some consequence as things now are among us.

Some have intimated that the miners' unions have been agitating this matter themselves, and are favorable to the plan, provided they can be satisfied that it does not cover an intention to reduce wages in the mines.—*Gold Hill News.*

THE LARGEST CONCRETE TANK IN ENGLAND.

THE students of the Institution of Civil Engineers lately visited the South Metropolitan Gas-works, adjoining the Surrey Canal, Old Kent Road, London, S. E., England. They were received by Mr. George Livesey, M.I.C.E., the engineer and secretary, who explained that the works themselves were forty years old, and contained few features more recent than fifteen years ago, except a series of large gas tanks and holders, in which the company was trying to solve the problem of erecting, at a reasonable outlay, capacious gasometers that should be water and gas tight, on a low, marshy site, of very unfavorable character for securing stability of foundation. Having shown the process of gas-making, from the reception and mixing of kinds of coal, the stoking of the retorts, to the cleaning of the gas through lime, bog-oxide and water, and in purifiers, washers, and scrubbers, Mr. Livesey led the way to the gasometers, which stand in line on the company's works in the order of time at which they were erected, as well as in size. The chief improvement has been in the construction of the tank. The soil of the company's works, after a few feet of loam and a layer of gravel, is a fine running greensand, shifting in position, if wet, at every disturbance of the bed, at the depth of about 45 feet; this is succeeded by a 6 inch layer of flints, and that again by chalk deposits of unknown thickness, pierced with numerous springs. The difficulty encountered was that as each fresh excavation for a tank was made the sand "ran" or "blowed," endangering those already built, and in some cases occasioning troublesome cracks and leaks, which had to be remedied. The first tank of the series was constructed in 1866, and is 127 feet 6 inches internal diameter, and is embedded 35 feet 6 inches below the surface. It was built in brickwork, surrounded by clay pudding to ground level, in order to render the sides impervious, and in the center a cone of puddle was erected as a support to the roof of gas holder. The next tank, formed in 1871–2, was 152 feet 6 inches diameter and 38 feet 6 inches deep. It was of "composite" character, of brick and concrete. The excavation was lined with 9 inch brick work, with a 14 inch course of bricks at every two feet, to serve as a keying for the concrete backing, varying from 42 inches at bottom to 18 inches. Hoop iron was introduced as bond about every five feet. At the foot was a course of stone, which was also used for piers and for the center of central cone, and, as before, clay puddle was filled in as a backing. The third tank, built in 1875–6, was 184 feet diameter by 47 feet deep, and in this the puddling and brickwork was replaced by concrete and cement rendering. The outer gas holder was 180 feet across by 45 feet, and the inner 177 feet by 45 feet 3 inches, and this had a roof of iron supported on timber work and iron struts resting on a brick cone.

This tank stood perfectly for a time, but, after being filled, five small cracks developed, and were now being repaired. The brickwork skin to the earlier tanks was adopted to save trouble in giving a true face to the work; but Mr. Livesey said he was satisfied it was needless as well as costly, and the present tank, like the last, is being constructed entirely in concrete, and when completed will be the largest of its kind. The dimensions as now being executed are 218 feet diameter and 55 feet 6 inches in depth. The contractors for this tank are Messrs. T. Docwra & Son, of Balls' Pond, N., who also built the previous tanks; and their contract, taken at £26,500, will be completed in about a month's time, and has now been in progress for twelve months, from Mr. Livesey's designs, and under his superintendence. The contract for the iron gas holder is in the hands of Messrs. Ashmore and Wiles, of Stockton-on-Tees, and will be commenced as soon as the tank is finished. Messrs. Docwra's manager is Mr. C. W. Robinson, who supplemented Mr. Livesey's explanations to the students, and conducted the party into the new tank. In excavating the site great difficulties were occasioned by the influx of water, not alone from the sub-soil, but also from springs in the chalk; and a "sump" has been formed to which the water is drawn from under the tank, and is pumped at the average rate of 1,800 gallons per minute into the sewers. The drainage holes in the tank are rendered round in cement, and will be calked up when the work is complete. Three hundred navvies, fourteen engines of from 6 to 25 h.p., three locomotives, and six steam cranes are employed on the works, besides two steam pumps.

Three 18 inch and three 15½ inch pumps are at work, capable of throwing 3,000 gallons per minute, and at the lowest excavations they were in full use. Only one horse has been in use during the work. The concrete used is composed of seven parts of ballast, mixed with broken retorts and clinkers from the gas works, to one of Portland cement. The walls vary in thickness from 3 feet at surface to 5 feet, the lowest portion being only 4 feet 6 inches thick. At intervals of every three or four feet this is strengthened by iron bands, 3½ inches wide by ⅛ inch thick, set edgeways in double row, and the face is rendered to a true surface in ¾ inch pure cement. This wall has been built by the ordinary boarding by day labor, no special apparatus being employed. The concrete is mixed in the tank, care being taken by cleaning off the surface before laying another course to secure homogeneity in the work. This wall is backed up by the green sand found *in situ*, which, when kept dry, forms a solid and water-tight packing. The great central cone for the support of the roof, the cylinder, upon it, 20 feet high, and 2 feet thick, and the base platform between the tank wall and this cone, are also of concrete, no puddle, brick, or stone being introduced, even for the heaviest work. Mr. Robinson mentioned that 13,000 14-foot deals, as timbers, and 3,000 struts, of an average length of 15 feet, had been used in support of the concrete walling. This work, as we have before intimated, is approaching completion, the cement rendering being in progress over a great portion of the wall. The holder to be placed within and upon this concrete substructure will be in three lifts, rising when full to a height of nearly 160 feet above the surrounding streets. The holder of 1872 at these works was constructed of ⅛ inch plates with occasional ribs of 3-16 inch metal; the extra thickness, instead of increasing the stability, was found to occasion unequal expansion and a slight "buckling," and the present holder will be throughout of ⅛ inch iron plates. The roof, which is supported by the gas when the holder is charged, will rest, when the vessel is empty, upon a timber frame not unlike the ribs of an umbrella, with simple struts between the beams. The usual cup and grip and water joints will be adopted to render the tank and holder gas tight. The total capacity of the new holder will be 5,678,000 cubic feet of gas, and the cost of tank and holder, including the necessary mains and connections, will exceed £50,000.—*Building News.*

SIEMENS' IMPROVEMENTS IN ELECTRIC RAILWAYS.

MR. SIEMENS, the constructor of the electric railway at the Berlin Industrial Exposition, has employed himself very diligently in perfecting and improving the first construction, and in applying electricity in various novel ways in propelling cars.

A combined steam and electric railway, constructed by W. Siemens, is shown in Figs. 1 and 2 of the annexed cuts. A series of short forked supports, constructed of glass or varnished wood, are arranged between the rails and support a copper rope, S.

The cars are provided with a dynamo machine, M, connected with the wheel pulleys by suitable belts or chains. The car is also provided with a series of rollers, *r*, *r*, over which the rope, S, passes as shown, and is raised from its supports and deposited as the car moves forward. By means of the rollers, *r*, *r*, and their supports, an electric connection between the rope and the dynamo machine is obtained. The return current passes through the iron frame of the car, the wheels, and the rails, or through another copper rope. A powerful dynamo machine is interposed between the two wires, or between the wire and the rails, at the end of the line, thus permitting any desired number of axles of the train to be rotated by electricity. In place of a wire rope, a fixed insulated rail connected with the car by brushers may be used. The electricity is especially adapted to be used as an assisting motor in ascending steep grades, and is also very efficient if used as a brake.

For the latter purpose the ends of the armature wires are connected so as to form a generator, which is rotated by the wheels of the car and heats the brusher, which must be cooled by a stream of water to prevent its melting. The resistance in the machine and belt is so great that the rotations of the wheel are checked very rapidly.

Figs. 3 and 4 represent Siemens' Electric Mail Railway. A tunnel of sheet iron, about twenty inches high, is supported by a series of iron supports, S, which may be of any desired height as circumstances may require. Sleepers, H, about twenty inches long, rest on the columns, S, and in turn support the side walls, b^2, of the tunnel, and the rails, a^1 and a^2, one of which is connected with the removable top, *d*, of the tunnel in several places; whereas the other is connected with every column, S. A small carriage, with two axles and with wheels, one and one-tenth inches high, rests on the rails. One of the axles consists of the shaft of a dynamo machine, so that every revolution of said machine produces one revolution of the wheels. One rail and the tunnel constitute the insulated conductor to the carriage the current passing through the wheels to the machine; whereas the other rail connected with the earth by the columns is for the return current. The rapidity of these carriages is as great as thirty-five to thirty-seven miles per hour.—*Maschinen Constructeur.*

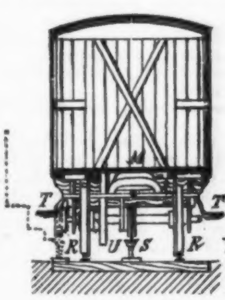


Fig. 1.

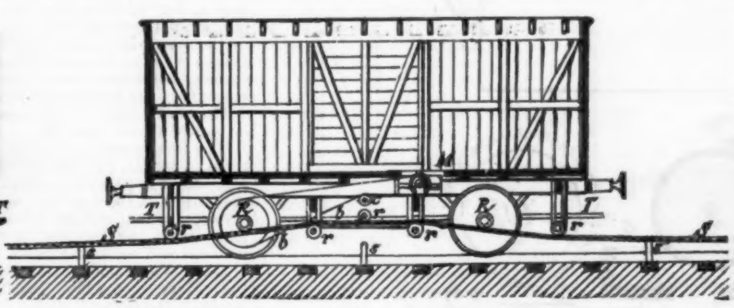


Fig. 2.

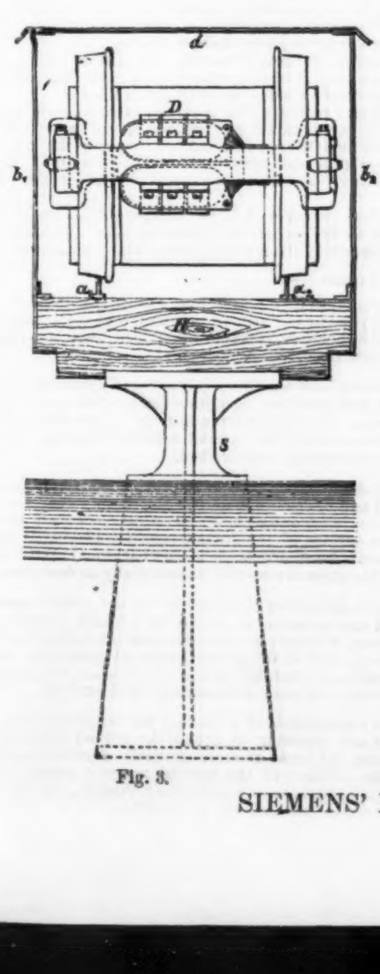


Fig. 3.

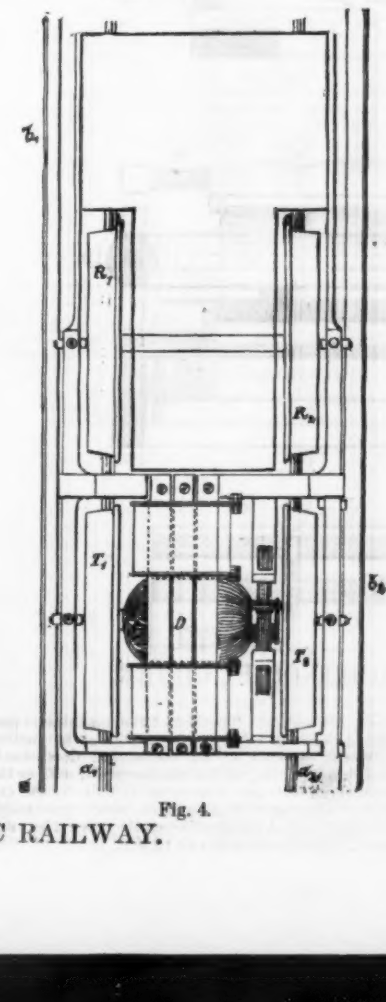


Fig. 4.

SIEMENS' ELECTRIC RAILWAY.

DIFFERENCE IN THE ACTIONS OF POSITIVE AND NEGATIVE ELECTRICITY.

THE authors, E. Mach and S. Doubrava, commence by referring to the experiments of Mach, Doubrava, Lullin, Lichtenberg, saying that the phenomena observed would appear to be enigmas, not subject to the present mathematical theory of electricity. They draw attention to the fact that, if any one set of phenomena be taken by themselves, it is easy to set up a plausible theory, but that the only way to arrive at the true explanation is to seek for one common source of all the phenomena. Reitlinger first pointed out a parallelism between Lichtenberg's figures and Faraday's luminous brushes, and he sought for an explanation in the motion of the air particles from the positive electrode. Plücker opposes this view, and looking at the experiments of Bezold, says that too little attention has been paid by Reitlinger to the nature of the dielectric. Thus again, in Lullin's experiment, which consisted in piercing a card by a discharge of electricity between two points on opposite sides of the card, but not quite opposed to one another, the hole is always found opposite the negative point. This was explained by Reitlinger to be due to the greater length of the positive brush; but the experiment succeeds equally well in carbonic dioxide where the brushes are short. Again Waltenhofen has shown that if we replace the card by some other substance, such as paper, the hole is made opposite the positive point. He came to the conclusion that the hole would be opposite the negative point in the case of all substances which when rubbed with damp air become negative, and that it would be opposite the positive point when the substance pierced was such that it became positive when rubbed with damp air. But this theory is incorrect, for the phenomena cannot be altered by electrifying the substance, or when we produce little explosions to assist the rush of air over the surface. The authors think that not only the surface, but also the internal constitution of the card, must be taken into account. They then proceed to describe numerous variations of Lullin's experiments, using a great number of points by placing strips and sharp pointed rhombs of tin foil upon the card, and by cutting little slits in the card. Such slits are only used by the spark if they come from negative poles. It seems, then, that paper, having negative potential, has a greater electrical firmness than when it is positive. They thought it worth while to test this assertion, which would explain many phenomena, and has a relation to the fundamental fact that of two bodies rubbed one becomes positive and the other negative. Doubling the card so that greater thicknesses are opposed to the negative point; finding if there is increased heat when a card is opposed to the positive point, or finding if in such a case there is greater potential difference before discharge; using double-pointed discharging rods with card over one negative point and card over one positive point, and finding the negative card pierced, and finding this is not the case if little balls are used instead of spheres; after all these experiments the authors say that although the above assertion may be kept up in a forced way, we have not gone much beyond Waltenhofen's assertion that Lullin's results depend on the material. The authors now proceed with centric symmetric arrangements. If a small sphere *a* is one electrode and a larger hollow concentric sphere A is the other, then a discharge more easily takes place between $-$ A and $+$ *a*, and indeed, between $+$ A and $-$ *a* it never becomes a spark, but only a brush discharge. Giving well known mathematical expressions for electromotive force between the spherical surfaces, the authors show that the rate of change of potential is no criterion of discharge. Both Righi and the authors made many analogous experiments, Righi's explanations of which are not satisfactory to the authors. Righi found a centric symmetric electrode of arrangement of the above kind of two metals A and B, such that whether A or B forms the material of the outer electrode, the discharge takes place more easily between $+$ A and $-$ B than between $-$ A and $+$ B.

The authors now proceed to consider length of spark discharge. Using a spark micrometer, they found that it required a greater difference of potentials to produce a spark through a given distance, when the Leyden jar was charged positively than when it was charged negatively, in the relation of 5 to 4. [The disposition of the apparatus is not quite clear. Compare experiments by Drs. De la Rue and Müller, Phil. Trans., Vol. 169.] If we discharge a plane condenser between two similar small ball electrodes, we find same length of spark when the coatings are at the potentials $+\frac{V}{2}$ and $-\frac{V}{2}$ or $-\frac{V}{2}$ and $+\frac{V}{2}$, but if we inclose the condenser in a case which has the potential $+\frac{V}{2}$ or $-\frac{V}{2}$, so as to make the coatings 0 and $+$ V or 0 and $-$ V, we get unequal lengths of sparks, although this case seems to be only immaterially different from the other. The authors here point out the difference in character between the equipotential surfaces in the case when the discharging balls are $+\frac{V}{2}$ and $-\frac{V}{2}$, and when they are $\pm$ V and 0, and show that this ought not to be of any consequence. They then surrounded their discharging balls only by a metallic case, which could be connected with one of them or to the earth, and found a difference in the length of spark depending on which of the two electrodes was positive. They describe a modification of this experiment. Again they inclosed the apparatus and themselves in a conducting case. They also took greater care in making experiments on length of spark with their micrometer arrangement. They revert to their consideration of fall of potential in the neighborhood of an electrode, saying that there may be a constant in the expression for distribution of potential, which does not change sign when we change the signs of the electricities, but they say that this cannot explain the phenomena observed.

Doubrava made some experiments alone. A water-pipe 6·8 inches in length, 8 inches in diameter, connecting the electrodes of a Holtz machine, showed at the middle a negative potential, and the zero was always nearer the positive than the negative electrode, and when the electrodes changed in sign the zero moved about one meter. A metal plate placed midway between two pointed electrodes had no charge if immersed in oil of turpentine, but was found to be positive if immersed in olive oil. When he surrounded the movable parts of his electroscope with oil of turpentine, it measured charges as usual, but if he used olive oil he found a difference of readings in the proportion of 3 : 4, according as his movable parts were positive or negative. The authors say that in all these experiments the influence of the material is evident, but the explanation is as yet unknown.—*Annalen der Physik und Chemie.*

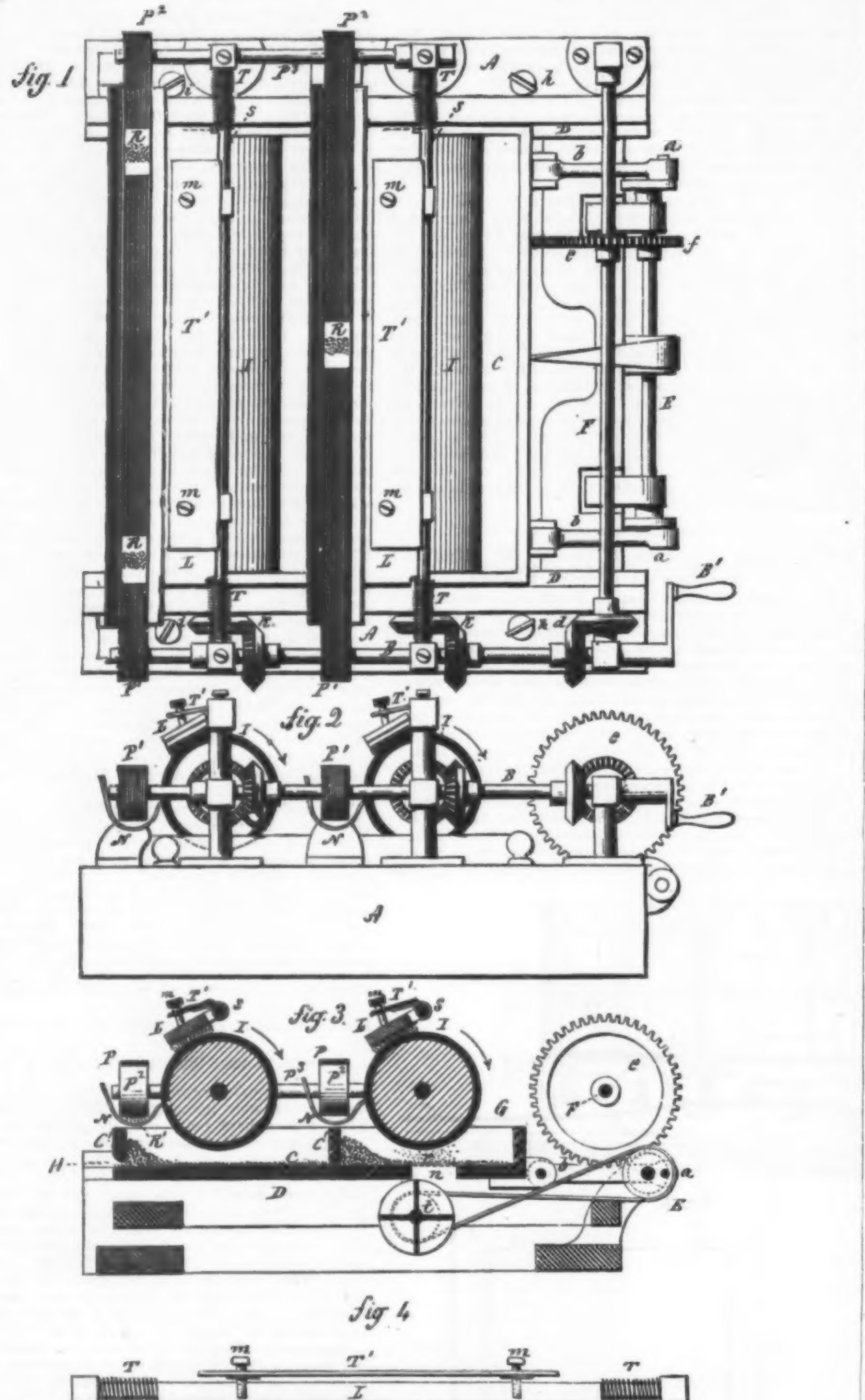
FORCE EXCITING ELECTRICITY.

EVERY heat phenomenon, emission as well as absorption, occasions under favorable circumstances an electric current. The current produced by the emission of heat has the opposite direction from that produced by absorption. If only one metal in a galvanic element is active, the electric force is proportional to the algebraic sum of the heat developed by the bodies acting upon each other within the element. If both metals are active the electric force is proportional to the difference of the algebraic heat sums on the one and the other side. The power of polarization in exciting electricity depends neither on the nature of the gas nor of the metal, but mainly on the chemical action springing from electrolysis. The power of two metals in one acid to produce electricity stands in a simple proportion to the heat which the metals in question evolve when they unite with the acid to form salts.—*Rad. Jugosl. Ak.*

THE NEW ELECTRICAL MIDDLINGS PURIFIER.

By THOMAS B. OSBORNE, of New Haven, Conn.

FIG. 1 is a top or plan view; Fig. 2, end view; Fig. 3, transverse section; Fig. 4, longitudinal section through one of the troughs; and Fig. 5, transverse section through the receiver-adjusting device.



THE NEW ELECTRICAL MIDDLINGS PURIFIER.

A represents the bed or frame of the machine, and on which the operative mechanism is arranged; B, the driving shaft, to which power may be applied in any known or convenient manner. (Here represented as by a crank, B'.) C is a receiver for the ground material, and is arranged so as to be moved on guides, D, and a rapid reciprocating movement is imparted to it by means of cranks, *a*, and pitman connections, *b*. The said cranks are arranged on a longitudinal shaft, E, to which a rotary motion is imparted through an intermediate shaft, F, in connection with the driving shaft, by bevel gears, *d*, and with the shaft, E, by pinions, *e f*, so that as the driving shaft is rotated a rapid reciprocating movement is imparted to the receiver, C.

The guides, D, which support the receiver, C, are arranged so as to be adjusted relatively to the rolls by means of screws, *h h* and *i i*. The bed of the machine is placed in an inclined position, or the guides, D, may be inclined, so as to give the receiver, C, an inclination downward from the receiving point, G, to the discharge, H, and so that the grain delivered into the receiver at G will, by the constant agitation or shaking of the receiver, work gradually along until it passes out at the discharge, H. (See Fig. 3.) The method of adjustment is shown in Fig. 4.

Longitudinally over the receiver several rolls, I, are arranged parallel with each other, and connected to the driving shaft by bevel gears, K, so as to be revolved in the direction denoted by the arrows, Fig. 3. These rolls run near the surface of the ground material in the receiver, and they are made from, or their surfaces coated with, hard rubber or equivalent material capable of being electrified or to present an electrified surface.

Above each roll, or at some point above the receiver, is a pad, L, presenting to each roll, and so as to bear upon it, a cushion or surface of wool or equivalent material which will generate more or less electricity in consequence of the hard rubber rubbing against the said cushion, and giving to the rolls an electrified surface and an attractive power which will take from the surface of the ground material the lighter particles, such particles rising and attaching themselves to the rolls by the attractive power thus generated, and, adhering to the rolls, they ride upon the surface until they strike the cushion, L, above, or some other obstruction, then, being detached, will drop into troughs, N, below, which are in such relative position to the rolls as to catch the particles when they drop therefrom. The said troughs extend over the receiver parallel with the rolls.

To discharge the material deposited in the troughs, an endless band, P, is arranged longitudinally over each of the troughs, running on a pulley, P', on the driving shaft, and over a corresponding pulley, P², on a shaft, P³, at the other end of the machine. These bands are provided with one or more sweeps, R, which run in close contact with the troughs, and so as to draw or sweep the material collected in the trough to and deliver it from one end.

The cushions, L, are hung on the shaft, S, and springs (here represented as spiral springs), T, act upon the cushion with a tendency to raise the cushion from the roll.

In order to adjust the friction of the cushion on the roll a plate, T', is rigidly attached to the shaft and extends therefrom over the cushion, as seen in Figs. 2 and 3, and through these plates, T, adjusting screws, *m*, are arranged, more or less in number, to bear directly upon the back of the cushion, and so that by turning the screws inward or downward the cushion is made to press upon the roll to the desired degree, or turning the screws in the opposite direction will accordingly relieve the friction.

The springs may be dispensed with, and a positive engagement of the cushion made with the screws, so that turning the screws in one direction will increase the pressure, and turning the screws in the opposite direction will relieve the pressure.

While the agitation of the receiver will tend to throw the lighter particles, which it is desirable to remove, to the surface, thence to be removed by the electrified surface, and which in some cases may be sufficient, the process is facilitated by a blast introduced from below, which will tend to blow the lighter particles upward through and above the mass or heavier particles. To this end I make an opening, *n* (see Fig. 3), and cover it with a fine open mesh, *r*, so fine and of such a nature that the ground material will not sift through it, but yet so that air may be readily forced through; then below the opening, *n*, a blast is arranged to discharge into said opening (here represented as by a blower or fan, *t*), arranged directly below the opening, but the necessary blast may be derived from any other source. This opening should be arranged near the roll, and so that the particles raised by the blast will be more readily taken by the roll—that is to say, the blast not only brings the lighter particles to the surface, but drives them to the roll or electrified surface, where they are caught and retained.

The blast should be regulated according to the quantity or nature of the material.

As a further aid in bringing to the surface the lighter particles, a bar, C', extends across the receiver in front of each roll, but so as to leave a slight opening between the bar and the bottom of the receiver, as seen in Fig. 3. The opening between the bar and the bottom is less than the depth of the material in the receiver; hence the constantly advancing material will bank up against the bars, as indicated in Fig. 3, and roll over and over against the partition, and increasing the surface upon which the roll may act, the material passing from the division under one roll through the opening below the bar into the next division, and so on until finally discharged.

While I have described the attracting surfaces as revolving rolls, it will be readily understood that this surface may be flat, or otherwise presented or moved so as to receive and discharge the particles by their movement.

The number of these attracting surfaces or rolls may be increased to any desirable extent in one and the same machine, the receiver being accordingly extended.

Instead of a reciprocating receiver, other devices may be employed—for instance, an endless apron, into which the grain shall be delivered and carried beneath the rolls. In that case a different agitator would be required—for instance, beaters to strike lightly upon the under side of the apron.

I therefore do not wish to be understood as limiting my invention to the particular construction or arrangement of parts as shown in the accompanying illustration; but

What I claim is—

1. The process herein described for purifying flour, consisting in passing the ground material, and at the same time agitating it, beneath movable electrified surfaces, substantially as described.

2. The combination of a receiver for the ground material, arranged and operating to agitate the ground material passing thereon, with one or more movable electrified surfaces above the surface of the ground material passing in the receiver, substantially as described.

3. The combination of a receiver for the ground material, arranged and operating to agitate the ground material passing thereon, with one or more movable electrified surfaces above the surface of the ground material passing in the receiver, and a blast arranged to discharge a current of air through the ground material, substantially as described.

4. The combination of a receiver for the ground material, arranged and operating to agitate the ground material passing thereon, with one or more movable electrified surfaces above the surface of the ground material passing in the receiver, and an adjustable cushion to regulate the power of the attracting surfaces, substantially as described.

5. The combination of a receiver for the ground material, arranged and operating to agitate the ground material passing thereon, with one or more movable electrified surfaces above the surface of the ground material passing in the receiver, and troughs to receive the particles from the electrified surfaces substantially as described.

6. The combination of a receiver for the ground material, arranged and operating to agitate the ground material passing thereon, with one or more movable electrified surfaces above the surface of the ground material passing in the receiver, troughs to receive the particles from the electrified surfaces, and moving sweeps to discharge the material from the troughs, substantially as described.

PHYSICAL SOCIETY, LONDON.

ORDINARY MEETING, May 8, 1880. Sir William Thomson, President, in the chair.

Photo-Electricity.—Prof. Minchin, of Cooper's Hill Engineering College, described his further researches in the subject of photo-electricity brought by him before the last meeting of the Society. He has found that the current in a sensitive silver cell does not always flow from the uncoated to the coated plate. It does when chloride or bromide of silver is used, but when the sensitive emulsion is iodide of silver and the liquid water tinctured with iodide of potassium, the current is from the coated to the uncoated plate. He demonstrated that the current set up by the fall of light on the cell could be sent by wire to a receiving cell and made to produce a local effect on the sensitive plate therein. He also proved that electricity is developed in fluorescent bodies by the action of light, and hopes to show that it is also developed in phosphorescent bodies. Neither heat nor the red rays produce this electricity, but it is the blue and violet rays which do so. The fluorescent silver plates he employed were coated with an emulsion of eosine and gelatine, and had kept sensitive for twelve days. They would thus be a permanent source of photo-electricity did the eosine not tend to leave the gelatine.

Mr. Wilson had suggested naphthaline red for eosine, as not apt to leave the gelatine, and he had found it give good results.

Electrometer Key.—Dr. O. J. Lodge described certain improvements which he had made in his electrometer key designed for delicate electrical and especially electrostatic experiments. Assisted by the British Association he had made it more convenient, and fitted it into an air-tight case which could be artificially dried. The contact pins were now of phosphor bronze, gilt, instead of platinum, and the contacts were made by press-pins from the outside. Dr. Lodge also exhibited a new inductometer or modified form of Prof. Hughes's induction balance, combining a Wheatstone balance, and expressly designed for comparing capacities and resistances, especially the resistances of coils having no self-induction. A telephone takes the place of a galvanometer in the bridge, and the current in the primary coil is interrupted by a clockwork make and break. There is one primary coil of fine wire, three and a half ohms in resistance, and two secondaries, one on each side of it, of fine wire, each about two hundred and seventy ohms; these are fixed, but the primary is adjustable by a screw.

Prof. Hughes remarked that he had pointed out in his paper to the Royal Society that the induction balance could be used in this way; and Dr. Lodge disclaimed any novelty in the apparatus beyond its arrangement.

Sir W. Thomson added that it was satisfactory to see so serviceable an adaptation of the induction balance to research.

Dr. Hopkinson, Prof. Perry, and Sir W. Thomson offered remarks on the element of time in comparing discharges from condensers of different dielectrics.

Sir W. Thomson said that, in 1864, he had made experiments on air and glass dielectrics, and found the discharge about the same for the first quarter second.

Prof. Adams then took the chair.

Air in Water.—Sir. W. Thomson made a communication on the elimination of air from a water steam-pressure thermometer, and on the construction of a water steam-pressure thermometer. He said it was a mistake to suppose that air was expelled by boiling water, because the water dissolved less air when warm than when cold. The fact was due to the relations between the density of air in water and the density of air in water vapor. There was fifty times more air in the water vapor over water in a sealed tube than in the water below. If this air could be suddenly expelled, only one-fiftieth part of air would remain, and of this only one two-thousand-five-hundredth in the water, the rest being in the vapor. This suggested a means of eliminating air from water, which he had employed with success. It consisted in boiling the water in a tube, and, by means of a fluid mercury valve, allowing a puff of the vapor to escape at intervals.

Steam Thermometer.—Sir W. Thomson also described his new water steam thermometer, now being made by Mr. Casella. It is based on the relations of temperature and pressure in water steam, as furnished by Regnault's or other tables, and will consist of a glass tube with two terminal bulbs, like a cryophorous, part containing water, part water steam, and the stem inclosed in a jacket of ice-cold water. Similar vapor thermometers will be formed, in which sulphurous acid and mercury will be used in place of water or in conjunction with it. For low or ordinary temperatures they will be more accurate than ordinary thermometers.

ATMOSPHERIC POLARIZATION.

THE philosophers who, from the time of Arago, have busied themselves with atmospheric polarization, have concluded that the plane of polarization of the light sent from any point of the sky passed through the sun, or was perpendicular to a plane passing through that luminary. M. Becquerel was led to think that this coincidence did not generally exist, so that he undertook the problem of determining exactly the relative positions of the sun and of the plane of polarization. After accumulating the results of two years' observations he has come to the conclusion that if we call a plane passing through any point of the sky the eye of the observer, and the center of the sun the *sun's plane*, then there is a variable angle between that plane and the plane of polarization of the light coming from the particular point looked at in the sky, such that the plane of polarization is always below the sun, that is, between it and the horizon. If the point looked at be north or south, and near the horizon, the angle is small in the early morning, reaches a maximum about 9 or 10 A.M., becomes naught at noon, reaches another maximum at 2 or 3 P.M., and becomes naught again at sunset. Toward the east or west no exact coincidence of the planes is observed, but there is a minimum about noon. In the morning and evening the angle between the sun's plane and the plane of polarization is tolerably large, as much as 6°; but near the time of coincidence there are perturbations which have prevented M. Becquerel following the movements of the plane of polarization near sunrise and sunset.

All the phenomena observed lead to the conclusion that the plane of polarization is twisted in the positive direction as seen by a person with his head toward the north and his feet toward the south, and that in the region perpendicular to the dipping needle the plane of polarization suffers practically no twist. The author, is, therefore, led to the conclusion that this rotation of the plane is due to terrestrial magnetism. Certain investigations, not yet concluded, have enabled him to calculate *a priori* the possible amount of rotation producible by the earth's magnetism when the thickness of air through which the light comes is known.

This thickness has of course not been accurately determined; but by making certain hypotheses he has arrived at the result that the probable theoretical amount of rotation of the plane of polarization due to terrestrial magnetism is of the same order as the observed value. At the same time, the theoretical value is too small to enable him to conclude that terrestrial magnetism is the sole cause of the observed rotation.—*H. Becquerel, in Jour. de Physique.*

LEAD POISONING.*

By DR. WM. PEPPER.

WE have here a girl, twenty-two years old, single, and who has been engaged as a chambermaid. She was admitted to the hospital some time ago, and has a somewhat uncertain history, but we may exclude entirely any suspicion of syphilis. It appears, from her history, that for a long time, dating back more than two years, she has been in the habit of employing, as a cosmetic, carbonate of lead, or white lead. She applied it every day, simply rubbing it over the face. She first noticed that her arms were becoming weak. She was admitted to the hospital with a double wrist drop. At the end of four months she had recovered sufficiently to leave the hospital, the extensors of the forearm acting normally. For two months after leaving she continued well, but at this time, after being exposed to cold and damp, she suffered from a severe attack of neuralgic pain in the stomach. She says she has not used the lead since her first attack. Three weeks after the attack of colic she noticed tingling pains in the arms, and the arms grew weaker and weaker, until at last she again had a double wrist drop.

When she came into the hospital this last time we found extreme constipation, marked double wrist drop, failure of power in the arms, and in addition to this, a blue line at the insertion of the teeth, but without any cerebral symptoms, no mental disturbance, nor pain about the head. She has had several attacks of colic.

Leaving the history, let us study her present condition. All the time that she has been in the hospital her mental condition has been good, nor has there been any disturbance of the cranial nerves. Her tongue is perfectly clean. The bowels are now regular. Examining the teeth, I find them very much discolored, either from want of cleanliness or stained by something that has been taken. The gums are slightly fungous and swollen, and have receded considerably from the neck of the teeth; this is more marked on the upper jaw. There is an imperfectly developed bluish red line at the junction of the gum with the teeth, more especially opposite the canines and premolars of both sides, but most marked on the left side of the upper jaw. This blue line is very characteristic.

Examining her arms, you see that she has power over her biceps, and is able to flex the forearm upon the arm, and also over the triceps, extending the forearm. She does not seem to have any power over the deltoid, to raise the arm over the head. Now, let us at once see whether this is due to a loss of power in the muscle or to adhesions in the point. Moving the arm in different directions, it seems to move freely in the glenoid cavity, but you see that this causes her intense pain. I desire you to notice this extreme sensitiveness, which has been a marked feature throughout the attack. You will observe, then, that there is great loss of power in the deltoid and the scapular group of muscles. When we come to study this more carefully we find that on both sides the deltoid muscles are considerably wasted. The atrophy is more marked upon the left than upon the right side. She has good power of pronation and supination. The flexors of the hand upon the forearm work well. The extensors of the fingers and of the hand upon the forearm are, on the left side, entirely paralyzed, but on the right the paralysis is not great. We have, then, great pain on moving the arm, but no adhesion in the joint, marked loss of power of the wrist and arm, with retention of power in the flexors. The paralysis of the extensors of the right hand is not so great as on the left side, for she can raise her right hand to the horizontal position. The paralysis was complete on this side when she came in. When I press upon the trunks of the nerves in the arm, she complains of severe pain. This same tenderness has extended to a considerable degree over the chest. There is no weakness or pain in the legs. The heart's action is rapid, but free from murmur. Here, then, is quite a complicated case, presenting some very marked conditions for our consideration and treatment, and we must try to arrive at a precise knowledge of its course and development.

We have here a symmetrical involvement of the nerves of the arms. This evidently does not come from any cerebral or spinal lesion. All the functions of the brain and cranial nerves are preserved. The loss of power and tenderness do not extend below the lower border of the ribs, the lower part of the abdomen and legs being entirely free from any evidence of nerve trouble. We see that the trouble is connected with the brachial plexus of each side. If we look at the distribution of the nerves forming the brachial plexus, we will find that only some of them are here involved, particularly the circumflex and branches of the musculo-spiral; but in addition to this, we find that evidently some of the sensory nerves are involved, as is shown by this extreme hyperæsthesia of the skin and by the soreness on pressure. This, although more marked over the nerve trunks, is not limited to these situations. This cutaneous hyperæsthesia is particularly marked over the distribution of the musculo-cutaneous nerve. The muscles that control the extension of the hands have been completely paralyzed, and we also find that the bodies of the muscles are almost completely atrophied. We have, then, to deal with a neuritis of both brachial plexuses, affecting not only the motor branches, but also the sensory branches.

Before going on to study the exact condition of the muscles, we must try to find out what has been the cause of this neuritis. Last week I showed you a case of neuritis resulting from traumatic causes. Again, syphilis is one of the most fruitful causes of neuritis affecting certain nerves. So common a cause is it, that, when you have a lesion singling out certain nerves, you must always investigate the history for syphilis. In this case we may exclude it. Another frequent cause is rheumatic inflammation, which, as we all know, affects the fibrous tissues all over the body, and it frequently affects the fibrous sheaves of the nerves, giving rise to marked neuritis. The history of this case goes to show that there has been no other rheumatic manifestations, and the case does not seem to be connected with anything that would give rise to rheumatism. Another very common cause of neuritis affecting certain nerve trunks, is poisoning from certain minerals, and especially from the absorption of an excessive quantity of lead into the system. Your attention will have been already directed to this case as one of lead poisoning. Let us, then, carefully study it, and see if this is its origin.

The absorption of lead may take place from any surface—from the mucous membrane of the respiratory passages, by the inhalation of vapor of lead or of dust containing particles of lead from the mucous membrane of the stomach, by being ingested in drinking water or food, or when taken as a medicine; from any of the other mucous surfaces, as those of the rectum and vagina, when lead is administered in suppositories; from the skin, when lead ointments are applied to the skin for a long time, or, as in this case, when it is applied in the form of a powder.

The symptoms of lead poisoning are very extraordinary, and would almost seem, at first sight, contradictory. Perhaps the most common and striking result of lead poisoning is lead colic, a violent, paroxysmal, painful affection of the abdominal nerves, the pain being seated at or about the umbilicus, and of an intense, twisting, griping, and binding character. This pain is usually relieved by firm pressure, so that the patient will often be found pressing upon the painful part, or leaning over a chair with the backing pressing against the abdomen. It does not seem, therefore, that the pain is caused by inflammation. While there is this intense pain, evidently of a neuralgic character, there is also marked evidence of paralysis of the muscle of the bowels, so that obstinate constipation is invariably present. We usually find vomiting also present. Where we meet with a case having these symptoms, with no evidence of indigestible matters having been taken, or of the passage of gall stones or of renal calculi, and the patient had been exposed to the action of lead, they would be very significant of lead poisoning. In other words, where you had a history of constipation, colic, and vomiting, without any jaundice, without blood in the urine, and without any disturbance of digestion, you would strongly suspect lead poisoning.

In addition to these attacks of colic, we have other evidences of the absorption of lead. One of the most marked is the appearance on the gum, particularly that of the upper jaw, at its junction with the teeth, of a blue line. This line, from the fact that it was first pointed out by Burton, of Leeds, is sometimes called Burton's blue line. It is an important diagnostic lesion when present. In some cases it is absent. There are other conditions of the system in which a similar line appears. In certain of the irritative stages of phthisis, a reddish line, differing in hue from the lead line, may appear upon the gum. These have been mistaken for the lead line. A few years ago I demonstrated that in nitrate of silver poisoning, a line scarcely distinguishable from the lead line appears. In the last two cases it is found that the discoloration depends upon the deposit of salts of lead or silver, formed by the action of the gases and acids derived from the decomposition of the juices and particles of food retained in the mouth. These salts, deposited upon the surface of the gum, gradually enter into the epithelial cells, so that by cutting out a piece of the mucous membrane, hardening it and examining it under the microscope, I have been able to show that the deposit enters into its deeper layers. It is possible that other substances may produce a similar line on the gums, but where we have a suspicion of lead poisoning, it is an important evidence. This girl has the blue line.

Going further, lead poisoning shows itself, in the next place, by a very strange selective affinity for certain nerve trunks and certain muscles, and evidently, on being absorbed, it is deposited in the muscular substance and the extremities of the nerve filaments of these parts. The first muscles involved are almost invariably the extensor muscles of the forearm. In consequence of the paralysis of these muscles, we have the characteristic symptom of wrist drop. From the fact that this affection occurs frequently in painters, it was formerly believed that it affected these muscles because they were used more than the other muscles. This is not the reason, for we find that it affects the left side as well as the right, and that it makes no difference what the occupation is, nor how the poison is absorbed. It is not only the extensors of the hand that are affected. About ten years ago there was a remarkable case of long continued lead poisoning under my care, which finally ended in death. The patient was paralyzed from the shoulders downward. After death I extracted lead from every portion of that patient's body. The lead, then, has an especial affinity for the muscles named, but when the saturation is extreme it will involve other muscles and other nerves.

When we come to consider the condition of the arm in lead palsy, we usually find that it is a painless affection. We do not find that it is due to a distinct neuritis, but that it is probably owing to the sedative influence of the lead upon the muscles and nerves. This is not always the case, for not only may we have palsy, but we may also have neuralgia depending upon lead poisoning. I have seen severe neuralgia of the cranial nerves, of the sciatic nerve, and of the brachial plexus, caused by and dependent upon lead poisoning. This double action, affecting the motor nerve, producing palsy, and the sensory nerves, producing neuralgia, is a singular and somewhat contradictory fact. We have seen an example of this action in the colic, where, in connection with the severe neuralgia of the nerves of the bowels, we have paralysis of its muscles.

It is evident that in this case we have a neuritis, as is shown by the marked tenderness over the nerve trunks, the tingling pain and the intense cutaneous hyperæsthesia. The question now arises whether or not this neuritis is dependent upon the action of the lead. We have here a history of long continued use of carbonate of lead, an unmistakable history of lead colic, with intense abdominal pain, vomiting, and constipation; we have the blue line upon the gums; and lastly, we have recurrent attacks of wrist drop. Under these circumstances we must regard her system as saturated with lead, and we must ascribe most of the symptoms to the action of the poison; but whether or not the patient has also contracted a double neuritis from cold is open to discussion; but it appears to me that where we have this complete history of lead poisoning, it is more reasonable to explain the sensory phenomena as due to the lead, than to refer them to the exposure. This case well illustrates the poisonous nature of this substance.

* A lecture delivered at the Philadelphia Hospital, November 12, 1879, by Dr. William Pepper, one of the physicians to the Hospital, and Professor of Clinical Medicine in the University of Pennsylvania.

Looking at the muscles of the arm, we find that they have not only been paralyzed, but also that their nutrition has been seriously interfered with. In the first place, as regards the action of the muscle toward electricity, after lead poisoning. The power of contracting under electrical stimulus is preserved for a short time after the muscle is paralyzed; but unless proper treatment is instituted the power of responding is quickly lost. I am now using a pretty strong current on the muscles of this left arm, but I obtain very feeble twitches. The muscles on the right side contract better, but their power is also much impaired. The extensors of the thumb act better than the common extensor of the fingers. The flexors contract powerfully. Soon after the power of responding to the Faradaic current disappears, the nutrition of the muscle suffers to a marked degree, and the muscle rapidly wastes, so that in prolonged and bad cases of lead poisoning the body of the muscle may entirely disappear. We have, then, not only the loss of power, but also the marked change in nutrition, showing the baneful effects of the poison upon the nerves and the various elements of the muscle. There is rarely any loss of sensibility.

Having, then, arrived at the diagnosis of lead poisoning, what is to be our treatment? The first part of the treatment should, of course, be the eliminative treatment. Our object is to rid the system of that lead which is in the alimentary canal and that which is in the tissues. In regard to the first, if the patient has been exposed to the poison just before coming under treatment, so that we have reason to believe that there is still more lead in the alimentary canal, we should give a purge of sulphate of magnesia and dilute sulphuric acid. This treatment should be kept up, in lessened doses, keeping the bowels in a soluble condition, for at least one week; but suppose we meet with a case, as here, where the patient has not used lead by the mouth; in such a case the purging treatment is not necessary. We must resort to a treatment that will stimulate the power of the system to absorb the lead, and will also get the lead in a condition to be absorbed. For this purpose no remedy is better than the iodide of potassium; with this should be given saline mineral water. It is on account of the diuretic and depurative action of these saline solutions, which also usually contain iodine and bromine, that certain mineral springs have acquired a reputation in the cure of lead palsy. The iodide of potassium should be given in pretty full doses; five grains, four times a day, continued for a long time, will, I think, usually remove the trouble. With this we should also use large quantities of saline solutions.

Now mark that this case shows us, in a very instructive way, how lead may be stored up in the system and give rise to repeated attacks of poisoning. How else could it be, when this girl came into the hospital with a characteristic attack of lead palsy and colic, and by treatment with the iodide of potassium the palsy was cured, and never coming in contact with lead in such a way that it could be absorbed, we find the symptoms recurring in even a more serious form? Undoubtedly, this new development of the symptoms is due to the absorption of lead from the tissues. I can explain it in no other way, and although this is a very rare occurrence, I see no reason why it should not take place. This patient should again be placed upon the eliminative treatment. The diet should be of a nutritious character, and the bowels should be kept soluble.

In the treatment of an attack of colic, the pain must be subdued by the hypodermic use of morphia, the administration of chlorodyne, or the use of ether. But we have even more important questions to settle than the relief of the colic, and these concern the muscles and the restoration of their power. As soon as we notice the slightest failure of power, we should commence the use of rubbing, kneading, and the application of Faradaic electricity to the affected muscles, and endeavor by every means in our power to diminish the paralysis and restore the nutrition of the part. In addition to this treatment, there is one drug which exercises a positive influence over the power of the muscles. That drug is strychnia. It exercises an unquestionable power in lead palsy, and should be given freely, beginning with gr. $\frac{1}{80}$, and gradually increasing the dose until gr. $\frac{1}{12}$ is taken, giving it cautiously and waiting a few days to see if any toxic symptoms are developed. In some cases you will get better results by injecting the drug directly into the body of the muscle. Strychnia is well borne when given in this way, and seldom causes any local irritation. When given by the mouth it gives almost equally good results.

In this case we have to deal not only with lead palsy, but also with a neuritis, and it is proper that we should direct our treatment to its relief. Over the tender spots I would place a few leeches or a blister, and keep up a continued counter irritation. In a case which has lasted so long, and where the system is so broken down, I would hesitate to use mercury.

The treatment of this patient for the next thirty days will consist of the use of iodide of potassium in such doses as will not interfere with digestion, strychnia, rubbing, frictions, Faradaic electricity to the paralyzed parts, counter irritation over the inflamed nerve trunks, free use of weak saline solutions, generous diet, and encouraging the patient to use the muscles as much as possible.—*Med. and Surg. Reporter.*

RECENT INVESTIGATIONS ON THE BLOOD.

It has, up to the present time, been believed that hæmoglobin, which exists in the blood of all vertebrate animals, is not crystallizable in all of them. M. Blanchard, however, states that the hæmoglobin of the blood of any animal will always be found in crystallized form, after the blood has remained for some time in the stomach of a leech. To obtain the crystals, it is only necessary to make a leech suck the blood of an animal and subsequently disgorge it. If the crystals be exposed to the vapor of a concentrated solution of osmic acid, they become insoluble in glycerine, and can be preserved for an indefinite period. The form in which iron exists in hæmoglobin is still a matter of dispute. Mr. Joly insists that it is always in the state of a phosphate. The blood of the octopus vulgaris, according to Frédéricq, contains no hæmoglobin, but in place of it a unique albuminoide substance, which he calls *hæmocyanine*, because, in its chemical constitution, copper takes the place of the iron in hæmoglobin. The venous blood of the octopus is colorless, the arterial blood a pronounced blue. M. Paul Bert, several years ago, discovered this same substance in the cuttle-fish, but did not give it a name. Frédéricq has also found it in the lobster. Hæmoglobin is frequently found in the leucocytes, and Prof. Kuhne, of Heidelberg, states, though on rather insufficient grounds, that he has also found it in the voluntary muscles. The quantity of hæmoglobin present in the blood of a man of ordinary size is estimated at about 125 grammes. The quantity is relatively larger at birth than at any other period of life; it is least between the ages of six months and five years, and then increases gradually, attaining its second highest point between the ages of twenty-five and forty-five years, after which it again decreases slightly. The quantity of hæmoglobin does not diminish appreciatively during the course of acute febrile diseases, but it does during a prolonged convalescence, and in chronic diseases.—*Le Progrès Médical.*

THE PULSE.

By T. A. McBRIDE, M.D., Lecturer on Symptomatology, Spring Course, College of Physicians and Surgeons, New York.

GENTLEMEN—We begin to-day with the study of the pulse. The word pulse is derived from the Latin *pulso*, I strike, and expresses the striking or lifting of the finger by the distending vessel, as, with each contraction of the heart, blood is forced into the vessels. The significance of the word has also been extended, so as to be applied to the appearance of a lifting up of the coverings over a distending vessel, so that the word *pulse* is applied not only to that which is felt, but to that which is seen.

There are two kinds of pulse—the arterial and the venous. The arterial is appreciated mainly by palpation, the venous by inspection. We have to study especially the arterial pulse.

In the writings of the old school of physicians, even to the days of Hippocrates, the pulse was regarded as one of the most important symptoms, and although some of the distinctions that these observers made were too fine and subtle to be really appreciated at the bedside, there can be no doubt that their observations of the changes in the pulse were often extremely acute and accurate. So accurate, indeed, that Dr. Broadbent, referring to these observations, says: * "It was with astonishment that I learnt, when I first took up the study, that every single element of the pulse revealed to us by the sphygmograph had been previously recognized by the old school of physicians, and that a nomenclature existed ready made for all of its teachings."

The radial pulse is the one usually selected, since it answers all of the requirements. It is of moderate size, is superficial, and can be readily compressed against the radius. The pulse in vessels elsewhere must sometimes of necessity be observed, as in the brachial, the facial in front of the masseter muscle, the temporal, posterior tibial, dorsalis pedis, the carotid and femoral arteries.

When the pulse is to be taken the patient should be either sitting or lying down. The observer should place his index, middle, and ring fingers lightly upon the pulse, and should then appreciate the state of the coats of the artery, and should next note the frequency, the rhythm, the tension, volume, and force of the pulse, and, lastly, any peculiarities if present. Moreover, the pulse of one side of the body should always be compared with the other. It should also be remembered that forcible extension or flexion of the forearm will sometimes arrest the radial pulse. In taking the pulse in children and infants it is well to count the pulse, if possible, while they are asleep. This can often be done nicely in the temporal artery. In taking the pulse at the wrist, asleep or awake, there are often involuntary movements of the arm and twitchings of the muscles, which render it difficult to keep the finger of the observer on the pulse. The difficulty may be overcome in a great degree by grasping the entire hand of the child and then extending the index finger upon the pulse.

It is also advisable not to take the pulse of the patient until some little time has elapsed after the appearance of the physician.

The factors of the pulse, and the several phenomena dependent upon them, are shown in the following table:

1. Heart.	a. Rate of frequency.	
	b. Rhythm—intermittency and irregularity.	
	c. Force or strength.	
	d. Quantity of the blood.	
2. Degree of resistance to the passage of blood through small arteries and capillaries.	a. Degree of tension.	Hard or long. Soft or short.
	b. Size of vessels.	Large. Small.
3. Elasticity of vessels.	a. Dicrotism, hyperdicrotism.	
	b. Non-dicrotism (senile pulse).	

In health, changes in the frequency and rhythm of the pulse are often met with.

I subjoin a table of the variations in the frequency of the pulse in health, which is taken from Hooper's "Physician's Vade-mecum," edited by Drs. Guy and Harley, and from this work is also taken most of what follows on the changes of the frequency of the pulse in health:

Infant asleep at birth	140
Infancy	120
Child five years of age	100
Youth	90
Male adults	72–80
Female adults	80–85
Old age	70

Heberden records 42, 30, and 26 beats to the minute in an old man of eighty, apparently in perfect health; Fordyce, another of 26 (Hooper's "Vade-mecum," p. 179, London, 1869). Great frequency in health is not often met with, but I have under observation a case where the pulse ranges from 100 to 120, and the individual states that this frequency has existed all his life.

Sex has some influence. Up to seven years of age the frequency is about the same in both sexes, but later the female pulse is from 6 to 14 beats—average 9, greater than in the male.

Posture also affects the pulse. It is most frequent in the standing, and least in the recumbent position. The pulse of a man is twice as much affected by change in position as that of a woman. When the pulse is much increased in frequency, change in position has but little effect, and for the higher numbers entirely disappears. When the head is lower than the body the pulse falls (a hint for the treatment of some forms of palpitation). The general law as to the degree of frequency of the pulse as affected by position is as follows: The frequency is directly proportioned to the amount of muscular effort required to support the body in different positions.

The pulse falls in sleep as much as ten beats. Sleeplessness increases its frequency. On awakening from sleep there is usually a decided increase in frequency.

Food increases the rate. Mental excitement and activity of the emotions increase the frequency; mental depression is often accompanied by a decrease. Cold lowers and heat raises the rate. Among other causes producing an increase in the frequency of the pulse in health may be mentioned spirituous and warm drinks, tobacco, diminished atmospheric pressure. Among the remaining causes producing diminished frequency there are fatigue, long-continued rest, debility without disease, and increased atmospheric pressure. Occasionally the pulse is *irregular* in health, but when that is so it is usually congenital.

Intermittency is not infrequent in health, and it is then either congenital or, as Dr. B. W. Richardson* has shown, may be due to terror, anxiety, grief, passion, mental or physical fatigue, adverse fortune, and old age. The intermittency may be only temporary, or it may become permanent; and if it becomes very frequent, may be pathological.

I now ask your attention to the pulse in disease, and I shall consider the subject under the following heads:

1st. The condition of the walls of the vessel the seat of pulsation.

2d. Changes referable to the several factors of the pulse.

3d. Names and significance of certain pulses.

1st. The condition of the walls of the vessel the seat of the pulsation.—In health, an artery of the size of the radial should not be felt in the interval of pulsation. When the artery can be easily appreciated in this interval the coats of the vessel have undergone some pathological change, or else the vessel is over-distended with blood; the blood pressure is greatly increased. The artery sometimes feels like a rubber tube with thick walls, or a pipe with rigid walls, or again, resembles a string of beads. It is often tortuous or serpentine, and may be traced up almost the entire forearm. These changes in the walls of the artery are the result of chronic inflammation, with subsequent degeneration—deposition of calcareous matter. Usually these changes are widely distributed in the arteries throughout the body. The temporal arteries especially are tortuous and serpentine, and sometimes the ophthalmoscope reveals thickening of the arteries at the fundus oculi. Changes in the coats of the arteries are observed in cases of Bright's disease, in the rheumatic and gouty, in the syphilitic, and sometimes in athletes, as the result of overstrain, and in lead-poisoning and scurvy. Excessive use of tobacco and alcohol occasion these changes. Certain infectious diseases besides syphilis seem also to excite pathological alterations of the walls of the vessels, as, for example, diphtheria and typhus fever. Exposure to cold and heat, want of food, or good air, also, may produce these changes; and, lastly, they may appear as among the earliest of the degenerations incident to senility.

It is important to appreciate the abnormal conditions of the walls of the artery in the following: In the diagnosis and prognosis of cerebral hemorrhage and thrombosis; in the prognosis, diagnosis, and treatment of changes in the aortic valves of the heart; and in the prognosis and just estimation of many diseases when found associated with this sign of beginning degeneration, and which may be the only positive sign of beginning decay.

I have already alluded to the fact that in pulse of high tension the vessel may be felt in the interval of pulsation, and one may be so deceived as to mistake such a condition of things for a vessel with diseased walls, whereas the artery is over-distended with blood and the walls may be normal. This is not so infrequently met with, and very often we find that disease of the walls eventually does supervene, apparently by reason of this condition of high tension. It may be necessary sometimes to differentiate these conditions, and Dr. Broadbent, in his interesting and valuable lectures on the pulse in the *Lancet*, 1875, to which I shall often refer, has demonstrated how perfectly this can be done by having the patient inhale some nitrite of amyl. If the pulse be one of high tension only, the thick, cork-like vessel disappears in the interval of pulsation, and is only felt during pulsation, and is then very soft. If the walls of the artery are actually thickened or diseased, very little change takes place. But, as I have said, you may find both combined, and the difference is in the change in the compressibility of the pulse.

2d. Phenomena referable to various factors of the pulse.

The Heart.—Increased and diminished frequency of the pulse.

a. Increased frequency.

I ask your attention to the following schemes of the causes of increased frequency of the heart as determined by experiment on animals. It is taken from Lauder Brunton's book on the "Experimental Investigation of the Action of Medicines," Part I., Circulation, London, 1875. I do this so that you may, if possible, explain to yourselves the probable cause of a frequent pulse in many conditions. I should be overstepping my limits of time were I to attempt it:

Paralysis of vagus roots or vagus fibers.	
" " " ends in the heart.	
Stimulation of the sympathetic roots.	Directly. Indirectly by lowered blood-pressure.
Stimulation of the cardiac ganglia.	Directly. Indirectly by increased temperature of the body.

A pulse of 90 or more may be regarded as a pulse of abnormal frequency in an adult. There are exceptions to this, but they are rare.

In the following pathological conditions a frequent pulse is of importance in diagnosis or prognosis:

1. *Fevers.*—"In fevers the pulse is generally quickened in proportion to the elevation of temperature, though the proportion between the pulse and the temperature varies in different fevers. In scarlet fever the pulse is quicker than in typhoid fever, with the same temperature, hence a quick pulse is of less serious import in scarlet than in typhoid fever. The same elevation of temperature quickens the pulse relatively much more in children than in adults.

"If a pulse is quicker than the temperature will explain, it indicates cardiac weakness, the weakness being proportionate to the want of ratio between the temperature and the pulse. In this way the pulse affords important information in prognosis and treatment.

"A pulse that day by day progressively increases in frequency, the temperature remaining the same, shows increasing cardiac weakness.

"In all febrile diseases a pulse in adults over 120 is serious and indicates cardiac weakness. A pulse of 130 or 140 indi-

* *Lancet*, vol. ii., 1875, p. 441.

* "Discourses on Practical Medicine: On Intermittent Pulse and Palpitation." London, 1871.

cates great danger, and with a pulse at 160 the patient almost always dies."*

a. In eruptive fevers, just before the appearance of the eruption, the pulse becomes sometimes very frequent.

b. In relapsing fever, during the febrile periods, the pulse is of very great frequency, and is often 130 to 140. It attains a greater degree of frequency than in any other fever, without being of grave significance (Murchison).†

c. In typhoid fever the prognosis is usually bad when pulse persistently exceeds 120 (Murchison).†

d. In the convalescence from all fevers the range of increase in the frequency of the pulse in changing from a recumbent to a sitting or standing position, or the range of decrease in its rate in changing from a standing or sitting to a recumbent position, is a measure of the debility of the patient. During the pyretic period such changes in position have little or no effect. The rate of the pulse may therefore be of importance in gauging the strength of the patient.

2. Inflammations:

a. The occurrence of a sustained frequency of the pulse after confinement is a very suspicious symptom, and may betoken advent of puerperal peritonitis.‡

b. Diseases of the lungs and pleura.

1. Under the age of fifteen any disease of the lungs is almost invariably accompanied by great frequency of the pulse, so that a pulse of 120 to 140 would not be considered as so serious in significance as if it occurred in an older person.

2. When a frequent pulse is present in pneumonia it is always of bad significance, even if only a small portion of the lung is involved. Moreover, when a pneumonia occurs in the cachectic or debilitated, the pulse is especially apt to be frequent, often 120 to 160, and such cases usually die.

3. When complicated with heart disease the frequency of the pulse is significant. Traube asserts, when in a strong robust person you find a pneumonia with a pulse of 120, you may be sure that there is present some form of heart disease.§

c. In the diagnosis of incipient phthisis a sustained frequency of pulse is thought to be of importance by Sir Thomas Watson and others.

d. In pleuritic effusions the pulse may be very frequent, especially when there is displacement of the heart.

e. In pericarditis and myocarditis very great frequency of the pulse is observed at times—especially on any movement by the patient—130 to 160. The change in rate may be very sudden, and is of some importance in diagnosis and prognosis.

f. In acute articular rheumatism unaccompanied by peri, endo, or myo carditis, a pulse of 120 or more indicates great danger (Ringer).

g. In the last stages of meningitis of the convexity, and particularly in tubercular meningitis, a very frequent pulse is often observed.

3. Diseases of the nervous system:

a. In diseases affecting the medulla oblongata—in glosso-labio-laryngeal paralysis the pulse is quite frequent.

b. In the early stage of locomotor ataxia a frequent pulse is a quite constant symptom.

c. In Basedow's disease a pulse of 120 to 140, and even of 200, is often observed at times.

d. In hysteria an exceedingly frequent pulse is not uncommon, 130 to 160 and more.

e. In puerperal mania, Sir James Y. Simpson insists upon the very great importance of the frequency of the pulse in prognosis, and he states that, where the pulse is 110 or over, the outlook is very bad, and that in his experience no case had ever recovered.

f. In certain cases of peripheral irritation a very great increase in the rate of the pulse has been observed:

1. Where tumors in the neck have pressed upon the pneumogastric or sympathetic nerves.

2. In cases with intra-thoracic tumors.

3. Where there has been some inflammatory process in the sheaths of the pneumogastric or sympathetic nerves.

4. In cases of irritation of nerves in the abdominal cavity, as by over-distention of the intestines by gas; in the passage of hepatic and renal calculi; worms in the intestines, etc. As showing the very great disturbance of the pulse, which may be occasioned by the presence of entozoa in the intestines, a case was reported in the *British Medical Journal*, June, 1867, in which attacks of palpitation of the heart with a pulse of 240 were observed, and, after the expulsion of a tænia from the intestines, the attacks entirely disappeared.

g. In nervous exhaustion, the result of venereal excesses, of over-indulgence in alcohol, coffee, or tobacco, or from excessive mental or physical labor, or as the result of previous disease, a very frequent pulse is often observed, and this may, when very frequent, have an alarming significance. Dr. Latham, in the new Sydenham edition of his works, vol. ii., p. 538, describes most eloquently the significance of the very frequent pulse. Likening the heart to the finger of the clock, he says: "We have already seen in these two cases the index hurrying rapidly round the dial plate, and telling that, from some cause or other, the mechanism within was running down, and, if it were not arrested, that it would quickly stop. Even prior to any outward presentments to give assurance of disease, even earlier than its known beginning, we have seen countless fluttering of the heart and arteries give token of the nervous system already under trial of mortal suffering, and ready to let life go for ever."—*Medical Record.*

*"A Hand-book of Therapeutics," by Sidney Ringer, M.D. William Wood & Co., New work, 1879, pp. 7 and 8.

†"A Treatise on Continued Fevers," by Charles Murchison, M.D., London, 1873.

‡"Pulse in Forming Stage of Puerperal Peritonitis." Archives of Practical Medicine, No. 3. Mary Putnam-Jacobi, M.D. New York, 1873

§"Die Symptome der krankheiten des Respirations und Circulations Apparats." Traube. Berlin, 1867, p. 31.

SOME EARLY SYMPTOMS OF INSANITY.

FEW general physicians, as we have heretofore remarked, are awake to the importance of watching for and treating early the symptoms of diseases of the mind. Too often the period in which such diseases may be prevented or successfully treated is allowed to pass by, under the convenient belief that the symptoms are "hysterical," or "nervous," or "sentimental" only. Every medical man who assumes the charge of families should commit to memory and keep in his recollection these words of the distinguished alienist, Dr. Daniel Hack Tuke: "Attack the first symptoms of mental ill health by appropriate means, and with at least as much determination as the first threatenings of consumption. Repel the invader before he can plant his foot firmly on your territory." ("Insanity in Ancient and Modern Life," page 143.)

Such is the variety of manifestations of mental ill-health that it is indeed often confusing to distinguish them, and the difficulty is increased by the delicacy of the inquiry. There are, however, two symptoms so generally present, so obvious and so significant of more than mere eccentricity or natural "queerness," that we would point them out as specially worthy of attracting attention.

The first of these is a *change in habits.* Whenever the man or woman who has for years been known as tidy becomes slovenly, as penurious becomes lavish, as taciturn becomes talkative, as serious becomes gay, as sedate becomes restless, as loving becomes surly, as confiding becomes suspicious, or the reverse, the gravest fears may be entertained as to their mental condition. Such is the force of habits on life that any material and sudden change in them can hardly take place unless associated with a disturbance of the central mental power itself.

It is hardly possible for the strongest argument applied to the reason to bring about such an alteration, however desirable it may be. The careless man, habitually neglectful of his own interests, unpunctual to his engagements, forgetful of his promises, loose in his dealing, may be, for all that, an excellent man at heart, and earnestly wish to reform his habits. He finds it most difficult to do so, practically, indeed, out of his power; and should he abruptly change in all these respects to what ordinarily would be esteemed much more praiseworthy courses, the suspicion may be justly entertained that it may prove a sign of mental weakness rather than of strength. Sudden conversions, violent reformations, are proverbially of short persistence, and are often signs of diminished rather than increased mental power.

Another most common symptom of the earliest stages of insanity is a condition of mental isolation. The social ties are loosened. This may present itself as an increasing selfishness, an indifference to the comfort of others, compared with the patient's own well-being, an excessive care of his health, and coddling about sanitary matters. His conversation becomes distinctly more about himself and his own personal interests than heretofore. They are magnified in his eyes, quite out of proportion, and both his infirmities and his capacities occupy his attention more than before. This morbid magnifying of self has been, indeed, a mild mental epidemic, which has afflicted the world at times within the last century.

Frequently associated with it, and a step further, in the direction of alienation, is the suspicion of others. This often begins with a diminution of the natural affections, passing into distrust and dislike. Not a few great men in history have suffered under the mania of persecution. Discouraged in their ambitions and brooding over their failures, they attributed the natural results of their actions to a plot to injure them. They saw conspirators in their best friends; and all that they had gained of fame and money but rendered them more wretched in view of the amount they had to lose.

Probably no general symptoms of insanity are more constantly present than these we have mentioned, and for that very reason we have thought it not amiss to bring them to the notice of the readers of this journal, as those for which they should be most on the lookout.—*Medical and Surgical Reporter.*

AN IMPROVED METHOD OF APPLYING ANTISEPTIC VAPORS.

PROF. GIUSEPPE CORRADI, in *Gazzetta Medica Italiana Provincie Venête,* January, 1880, commences with a review of what he considers the chief advantages and inconveniences of the antiseptic method as at present practiced. Besides the danger of carbolic acid poisoning, which he believes to be always present when large injections of the acid are used, and the irritation of skin frequently produced by the gauze, there is the extreme discomfort caused to the surgeon, whose eyes and throat are irritated by the spray, and who is precluded from the use of such instruments as the galvano cautery, or the thermocautery of Paquelin. To obviate these inconveniences, the author suggests and has practiced a method by which a jet of chemically pure air, impregnated with the fumes of carbolic acid or other volatile disinfectant, can be made to play upon the part to be operated on. This object he accomplishes by means of a fan, giving a continuous blast, the air to supply which is made to pass previously through a diaphragm of wadding. By this means it is deprived of all its "atmospheric dust." The air as it leaves the fan is next conducted into a Wolfe's bottle, one-third filled with pure, anhydrous, carbolic acid. Here it becomes strongly impregnated with the acid, and thence passes into an India-rubber tube with a rose end, which distributes it in the immediate neighborhood of the operation, or, if preferred, exactly over the spot. The author has also made trial of sulphuric acid instead of carbolic, but does not recommmend it. By fitting a supplementary pipe to the main tube, he has been able to add the vapor obtained by burning various substances, such as charcoal and benzoin, leaves of uva ursi, tobacco, etc. He has already practiced this method successfully in one capital operation, but would be glad to learn the experiences of any who are able to apply it on a large scale.

TREATMENT OF PHTHISIS BY INHALATION OF BORAX AND SALICYLIC ACID.

DR. MÜLLER, a Berlin chemist, lays claim to the priority in the employment of antiseptic inhalations in the treatment of phthisis. He states that he recommended inhalations of borax and salicylic acid in a case of phthisis in 1876, and that his suggestion was carried into effect by Dr. Sachse, of Berlin, with remarkable success. He was led to make this suggestion by the theory, that in pulmonary phthisis a portion of the lungs is in a state of decomposition, or of alkaline fermentation, and as similar processes in open wounds are controlled by antiseptics, so the inhalation of antiseptics might be expected to exert an inhibitory action on the morbid processes in the lungs, and thus effect a cure. He recommended for this purpose salicylic acid, which was made easily soluble by the addition of borax. This combination is quite as powerfully antiseptic as the benzoate of soda, and is, he believes, preferable to it, because it acts more energetically on the alkaline fermentation in the lungs, and produces no deleterious effects. The solution he recommended was 750 parts water, 25 parts salicylic acid, and 19½ parts borax.

Dr. Sachse, in an open letter, confirms the claims of Dr. Müller, and states that he has since employed the borax-salicylic acid inhalations in a number of cases, of which he gives brief accounts, with, on the whole, very satisfactory results. He uses a solution of two parts borax, 2½ parts salicylic acid, and 100 to 150 parts hot water, and orders the inhalations to be practiced morning and evening for five or ten minutes, instructing the patients not only to inspire deeply, but particularly to make deep and prolonged expirations. The inhalations often caused, at first, cough and a slight burning sensation in the neck, and some of the patients complained of loss of appetite, due to swallowing a good deal of the fluid; in such cases the solution was diluted with an equal quantity of hot water, until the patients became accustomed to it. The taste of the solution is bitter and very unpleasant. No hæmoptysis occurred in any of the cases after the inhalations.—*Allg. med. Cent.-Zeit.*

DETECTION OF STARCH SUGAR IN CANE SUGAR.*

By P. CASAMAJOR.

ABOUT a year ago we were often entertained by the daily press with accounts of the adulterations practiced by sugar refiners, and among these adulterations, the one most generally used, as we were then told, was the mixing of refined sugar with starch glucose. I must confess that I never believed in such a practice; for, although I had tried to procure specimens of such sugars, I was not able to find any, and one or two specimens which were given to me, as of sugar so adulterated, turned out to be pure, as far as the presence of starch sugar was concerned. The idea that these sugars were so adulterated very likely originated in the imperfection of the processes used to detect the presence of starch sugar.

This week, however, I have had the good fortune to come in possession of a sample of refined sugar largely adulterated with starch glucose. This sample was sent to Messrs. Havemeyer & Elder from St. Louis, and a slip of paper in the box gave the information that the barrel from which this sugar was taken was marked "Powdered Sugar, Manhattan Sugar Refinery, New York;" a refinery of the existence of which I have not been able to find any proof.

The incredulity which I previously maintained on the existence of adulteration by starch sugar was based on the following considerations:

From a sugar solution you can only obtain, by the ordinary processes of a refinery, a quantity of crystallized sugar representing very nearly the difference between the cane sugar present and the soluble impurities. If you have, for instance, a sugar solution whose co-efficient of purity is 90 per cent. the soluble impurities will represent 10 per cent. of the total of the substances in solution, and you can obtain, at the utmost, only 90—10=80 parts of sugar from 100 parts of substances dissolved. Processes have been published whereby a greater yield may be obtained, but such processes require the use of alcohol or of large quantities of salts of magnesia, and they have never been used in any extended scale. As starch sugar in solution does not act otherwise than any other impurity in solution, the addition of it in a dissolved state to a sugar solution could not have any other effect than to diminish the yield of sugar and increase that of molasses.

The only manner in which starch glucose can be mixed with refined cane sugar, so as to give a profit, instead of a loss, to the person effecting this mixture, is to mix the two substances in a solid state. Now, the starch sugar must either be added in large quantities—and then it seemed to me that it could be easily detected by the eye or by the taste; or it must be added in very small quantities, and then the difference between the price of sugar and that of starch glucose would not leave a profit proportional to the trouble. My experience with sugar refiners does not lead me to believe that the refiner exists who would adulterate his products by adding to them only one or two per cent. of starch glucose. Such a thing would not pay.

The object of this communication is to give a few easy processes for the detection of starch glucose in commercial sugar.

By the use of the optical saccharometer the presence of starch sugar may be easily detected, when in quantities as large as in the sample in question. It is a dextro-gyrate substance, and no other dextro-gyrate substance could be used to adulterate sugar with efficiency in such large quantities.

The direct test by the optical saccharometer gives 97 per cent. After inversion, the reading of the saccharometer is 9·8 per cent to the left at 21°C. If we add these numbers we find by Clerget's table that they correspond to 80 per cent of cane sugar. As the sugar is dry, the balance, 20 per cent., nearly represents the quantity of starch sugar, as from the appearance of the sugar there must be very little inverted sugar present.

I need not now consider the subject of inversion as a means of ascertaining the actual quantity of cane sugar present in a sample of commercial sugar, as I have already had occasion, in a paper read before this Society at our regular meeting of February of last year, to discuss this subject at great length.† I may, however, say that if this sugar had been what we call in the sugar business a *straight sugar*, 97 per cent. of sugar, after inversion, would have given at 21° C.—32·5°, instead of —9·8°. I call attention to this to show of what precious help the process of Clerget is in cases of this kind. It is a sad truth that very many persons, whose occupation is the analysis of sugars, are either entirely ignorant of the process of Clerget, or they do not know enough about it to use it when they need it.

This sugar, tested by the alkaline copper solution, gives 17 per cent. of reducing substances calculated as glucose, which shows that the starch sugar mixed with refined sugar contained $\frac{17}{20}$=85 per cent. of these reducing substances.

The process which I had the honor of describing before this Society at our June meeting‡ gives unsatisfactory results with sugar adulterated by starch glucose. This is due to the imperfect solubility of starch glucose in methylic alcohol. After grinding the sugar under examination with the standard solution for three minutes, the process gave 85 per cent. of pure sugar—a discrepancy from the result by the saccharometer (80 per cent.) which never takes place with straight sugars.

Besides these processes, which can only be applied by persons provided with scientific appliances, the presence of starch glucose, when used in such large quantities, may be readily detected by very simple processes, which may be

* Read before the American Chemical Society.

† See "Journal of the American Chemical Society," vol. i. p. 26; also *Chemical News*, vol. xxxix., pp. 212-234, *Sugar Cane*, vol. xi., p. 296; *Moniteur Scientifique*, Juin, 1879, p. 647; *Stammer's Zeitschrift*, Juli, 1879, p. 683.

‡ See "Journal of the American Chemical Society," vol. i., p. 208, also *Chemical News*, vol. xl., pp. 74, 97, 107, 131, *Sugar Cane*, vol. xi., pp. 581, 588, 608; *Zeitschrift des Vereins*, October, 1879, p. 957; *Ann. de Chemie et de Phys.*, 5th series, vol. 18, p. 559.

applied by anybody who wishes to use such means as are always at hand.

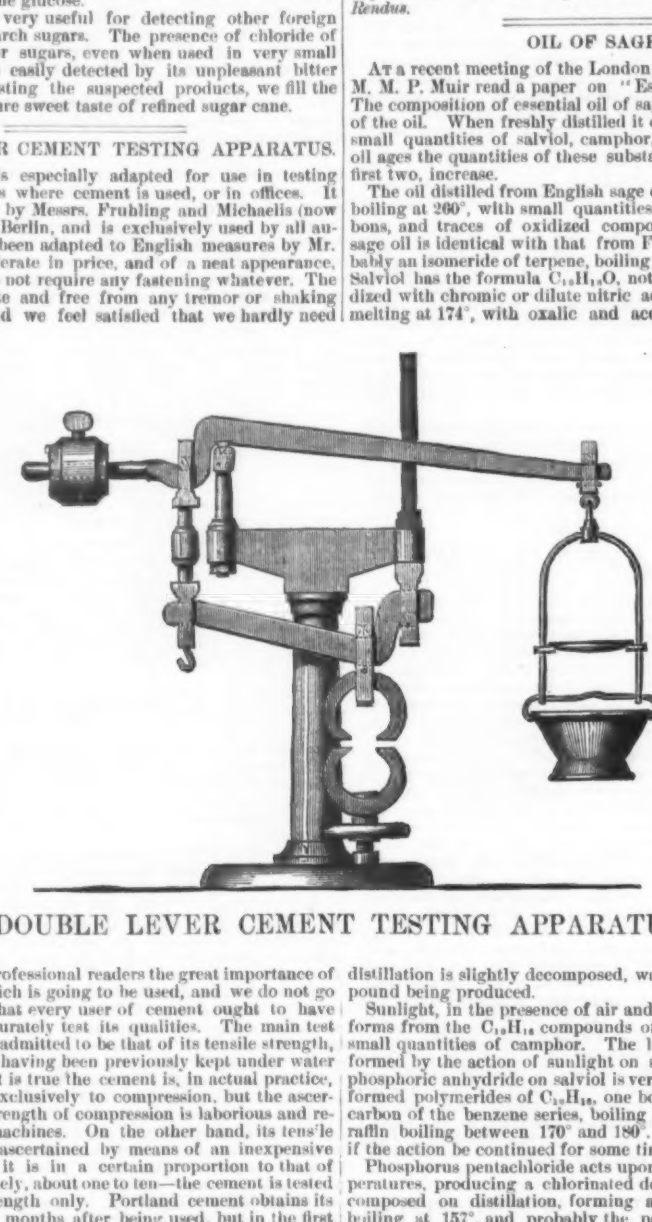
One process for the detection of starch glucose consists in adding to the suspected sugar somewhat less than its own weight of cold water and stirring for a few seconds. If starch sugar is present, it will be seen floating in the solution as white specks which resemble crushed wheat. This appearance is due to the comparative insolubility of starch glucose in cold water, which allows it to remain undissolved quite a long time, and also to the fact that as the cane sugar present is crystalline, and its refrangibility is not very different from that of a sugar solution, the portion of it which remains undissolved is not so distinctly seen as the specks of starch sugar. These specks are best seen by using a beaker glass, and putting only enough sugar and enough water that we may be able to see light through the flat bottom of the glass. If a flat-bottomed glass is not at hand, the observation may be made on a pane of glass.

This process for the detection of mixtures of starch glucose with cane sugar is so simple and satisfactory that I might well be excused from giving another, but the one I am about to give is useful for the detection of other foreign substances in the products of refineries. This process is based on this, that the taste of sugar has a tendency to dull our perceptions of the taste of other substances mixed with sugar. So as to neutralize this effect of sugar, we may, before tasting a suspected sample, put a pinch of pure sugar in the mouth. If after this sugar is dissolved, but while we still perceive its sweet taste, we put on the tongue a pinch of sugar containing starch glucose, we distinctly perceive the bitterish taste of the glucose.

This process is very useful for detecting other foreign matters besides starch sugars. The presence of chloride of tin in molasses or sugars, even when used in very small quantities, can be easily detected by its unpleasant bitter taste if, before tasting the suspected products, we fill the mouth with the pure sweet taste of refined sugar cane.

DOUBLE LEVER CEMENT TESTING APPARATUS.

THE machine is especially adapted for use in testing rooms at the works where cement is used, or in offices. It has been designed by Messrs. Frubling and Michaelis (now W. Michaelis), of Berlin, and is exclusively used by all authorities, and has been adapted to English measures by Mr. Holste. It is moderate in price, and of a neat appearance, portable, and does not require any fastening whatever. The machine is accurate and free from any tremor or shaking during the test, and we feel satisfied that we hardly need point out to our professional readers the great importance of testing cement which is going to be used, and we do not go too far in saying that every user of cement ought to have some means to accurately test its qualities. The main test is now universally admitted to be that of its tensile strength, the test briquettes having been previously kept under water for seven days. It is true the cement is, in actual practice, subjected almost exclusively to compression, but the ascertainment of the strength of compression is laborious and requires expensive machines. On the other hand, its tensile strength is easily ascertained by means of an inexpensive apparatus, and as it is in a certain proportion to that of compression—namely, about one to ten—the cement is tested for its tensile strength only. Portland cement obtains its full strength many months after being used, but in the first seven days about 60 per cent. of it. As it hardens very slowly afterwards, its behavior after the first seven days is considered sufficiently indicative of its qualities for all practical purposes. Of course, the older the briquettes are the safer the conclusions to be drawn from the tests. Briquettes of neat cement should withstand a tensile strain of 350 lb. per square inch, and about 20 per cent of this, or 70 lb., if mixed with three parts of clean sharp river sand. The description of the apparatus is as follows: It consists of a column of japanned cast iron, which carries two levers, the leverage of the upper and longer one being one to ten, and that of the lower and shorter one one to five; the combined leverage is therefore one to fifty. Each lever has three knife edges. The prolongation of the upper lever is provided with a counterweight for securing the correct position of the levers, which is indicated by a mark on the catch fastened to the top of the column. To the lower is fixed one of the jaws for holding the briquettes; the other is attached to the base of the column, and may be adjusted by means of a screw and wheel. The long arm of the upper lever carries a light frame, on which the shot pan is hung, all parts being highly finished and polished. The test is now made as follows: The briquette is taken out of water, in which it has been immersed for seven days, dried, and then placed in the two jaws, which fit exactly to the sides of the briquette. The adjustment is effected by the above mentioned screw and wheel. The pan is now hung on the light frame suspended from the long end of the upper lever, and fine shot is poured into it out of a can with a spout, till the fracture takes place. The breaking strain is thus exactly fifty times as large as the weight of the pan with the shot, which weight may be easily ascertained on any ordinary scale. To avoid all calculation and possible error, special spring scales are provided, from the dials of which the breaking strain can be at once read. Another improvement consists in using a different kind of spring scale, which is hung on the long arm of the upper lever, instead of the above mentioned light frame. The dial of this scale, of course, allows also a direct reading off of the breaking strain. This improvement was made with a view of reducing the number of parts.—*Colliery Guardian.*



DOUBLE LEVER CEMENT TESTING APPARATUS.

PREDICTION OF CHEMICAL ELEMENTS.

IN awarding the L. Lacaze prize to Boisbaudran, for the discovery of gallium, the committee remarked that the new element was not obtained by accident or by any spectroscopic indications. Its discoverer was led, by theory, to seek, in ores of zinc, an element which was required in order to fill a vacancy in his classification. By operating upon 52 kilogrammes (114·64 lbs.) of blende he succeeded in obtaining one-hundredth of a milligramme (0·000154 grain) of gallium; in other words, in order to obtain a unit of gallium he was obliged to use five thousand million units of blende. By pursuing his investigations Boisbaudran found that there was a very close agreement between the properties of gallium and those which had been previously announced by Mendelejeff, as belonging to a metal which was required to fill a vacancy in his classification.—*Comptes Rendus.*

OIL OF SAGE.

AT a recent meeting of the London Chemical Society, Mr. M. M. P. Muir read a paper on "Essential Oil of Sage." The composition of essential oil of sage varies with the age of the oil. When freshly distilled it contains comparatively small quantities of salviol, camphor, and cedrene. As the oil ages the quantities of these substances, especially of the first two, increase.

The oil distilled from English sage contains much cedrene, boiling at 260°, with small quantities of $C_{10}H_{16}$, hydrocarbons, and traces of oxidized compounds. The terpene of sage oil is identical with that from French turpentine; probably an isomeride of terpene, boiling at 171°, is also present. Salviol has the formula $C_{10}H_{16}O$, not $C_{10}H_{18}O$. When oxidized with chromic or dilute nitric acid it yields camphor, melting at 174°, with oxalic and acetic acids. Salviol on distillation is slightly decomposed, water and a $C_{10}H_{16}$ compound being produced.

Sunlight, in the presence of air and in the course of time, forms from the $C_{10}H_{16}$ compounds of sage oil, salviol, and small quantities of camphor. The latter substance is also formed by the action of sunlight on salviol. The action of phosphoric anhydride on salviol is very complex, there being formed polymerides of $C_{10}H_{16}$, one boiling at 171°, a hydrocarbon of the benzene series, boiling below 130°, and a paraffin boiling between 170° and 180°. No cymene is found if the action be continued for some time.

Phosphorus pentachloride acts upon salviol at high temperatures, producing a chlorinated derivative, which is decomposed on distillation, forming a $C_{10}H_{16}$ hydrocarbon, boiling at 157°, and probably the paraffin-like body mentioned above.

Bromine acts energetically on salviol, hydrogen and carbon being liberated. A brominated oil may be separated, and under certain conditions small quantities of camphor melting at 174°. Camphor separates chiefly from the portions of sage oil, distilling between 205° and 208°; it is partially soluble in salviol, but separates out on cooling the solution to —15°.

Sage camphor melts at 174°, and boils at 205°. Chemically, it appears to be identical with laurel camphor; it is, however, optically inactive. The compounds present in sage oil are stable when pure, but when mixed with small quantities of other bodies they decompose. Processes of oxidation, deoxidation, and polymerization probably occur simultaneously during the aging and fractionation of sage oil.

In discussing his results the author expresses an opinion that the camphor group may be regarded as a link between the "closed chain" and the $C_{10}H_{16}$ series, just as the $C_{10}H_{16}$ group forms a link between the fatty and the closed chain compounds.

Dr. Wright complimented the author on the completeness of his paper. Though some of the reactions had been already worked out, additional and more complete evidence was always very valuable. He thought the author's views as to the relation between the closed chain compounds and the camphors were open to discussion.

Mr. Kingzett had been much interested in the paper, as it seemed that in many points the oxidation of sage oil was analogous to that of the terpenes. In one experiment he had obtained from turpentine colorless crystals closely resembling camphor. He should like to ask if Mr. Muir had observed during the oxidation of sage oil in the air any production of hydroxyl.

Mr. Muir had not specially looked for hydroxyl during the present investigation, but had noticed its formation in a previous research. He also replied to the criticisms of Dr. Wright on the theoretical portion of the paper.

BRONZING IRON.

To one pint of methylated finish add 4 oz. of shellac and ½ oz. benzoin; put the bottle in a warm place, shaking it occasionally. When the gum is dissolved let it stand in a cool place two or three days to settle, then gently pour off the clear mixture into another bottle, cork it well, and keep it for finest work. The sediment left in the first bottle, by adding a sufficient quantity of spirit to make it workable, will do for the first coat or coarser work when strained through a fine cloth. Next get ½ lb. of finely ground bronze green—the shade may be varied by using a little lamp black, red ocher, or yellow ocher; let the iron be clean and smooth, then take as much varnish as may be required, and add the green color in sufficient quantity; slightly warm the article to be bronzed, and with a soft brush lay on it a thin coat. When that is dry, if necessary, lay another coat on, and repeat until well covered. Take a small quantity of the varnish and touch the prominent parts with it; before it is dry, with a dry pencil lay on a small quantity of gold powder, and then varnish the whole.

RUST-PREVENTING COMPOUND.

AN improved composition has been patented by Herr Engel, of Hambu rg, for coating metals. It consists of solid hydrocarbons in combination with liquid hydrocarbons, etheric or fat oils. Among the solid hydrocarbons, preferably India-rubber, paraffin, and ozokerit are used, while among the liquid hydrocarbons and oils, rectified petroleum, ligroine, and turpentine oil are preferably applied for the manufacture of the above composition. A valuable composition is produced by melting one part of paraffin under moderate heat, about 150° Fahrenheit, in a closed vessel, and by then adding and mixing from two or four parts of rectified petroleum, ligroine, or turpentine oil, with the melted paraffin. According to the greater or lesser quantity of liquid which is added, the consistency of the composition varies. It can be applied to the surface of the metals by means of a stiff brush.

ARGENTINE SHEEP AND WOOL.

THE country ranking second in importance in the supply of the wools of commerce is the Argentine Republic. The number of sheep, as stated a year or two ago by Dr. Oldendorff, from a numeration made by himself as commissioner of her agricultural department, is 57,501,200, with an annual yield of 216,000,000 pounds of wool, all of which, as there are only one or two wool manufacturers in the republic, may be said to be destined for export.

The details as to the numbers and distribution in the several provinces of this republic, as furnished from the census of 1876, are as follows:

	Number.	Value.
Buenos Ayres..........	45,511,358	$72,818,172
Entre Rios..............	3,000,0(0	3,600,000
Santiago..................	1,200,000	960,000
Sante Fe..................	4,500,000	3,600,000
Corrientes...............	770,846	878,000
Cordova	1,405,638	1,060,000
San Luis	113,815	170,000
Catamarca...............	114,420	145,000
La Rioja..................	53,932	108,000
Tucuman..................	70,000	56,000
Mendoza....	53,856	94,500
San Juan..................	120,200	285,000
Jujuy.......................	514,621	331,473
Satta.......................	64,930	46,000
	58,493,616	$84,152,145

The chief portion of these exports consists of merino wools. The exhibits of wools from the Argentine Republic, at the Philadelphia Exhibition, with the exception of that of Mr. Samuel B. Hale, scarcely did justice to the importance of this production. The most noticeable feature was the enormous size of some of the fleeces of merino wool of the Rambouillet and Negretti stock—one fleece, a pure-bred Negretti ram, grown in eleven months and eighteen days, weighed 31 pounds; other Rambouillet fleeces weighed 25 and 27 pounds. Two pelts were shown from sheep of the same race—one which measured 5 feet 6 inches in length and 4 feet in width at the hips, with a staple 9 inches in length. These fleeces, although they might exhibit the recent attempts for improvement, did not illustrate the general character of the merino wool of this country. The general characteristic of these wools is lightness of fleece, the weight not usually much exceeding 3 pounds in the grease to the fleece. They are fine, soft, and short, and principally suited for the card, though generally wanting in strength and nerve. Their principal defect, however, is the clinging to the fleece of the *carrotilla* or burr from the clover or white medoc on which these sheep feed, which seems to be inseparably connected with the productive lands and best pasturage. Notwithstanding these defects, which are obviated by burring machinery, and more recently by chemical processes applied either to the wool or to the cloth, these wools are in high esteem with the cloth manufacturers, especially of Belgium and France.

The Argentine Republic vies with Australia in representing the results of the merino wool culture in the last century. The raising of fine sheep was not seriously commenced until 1826, when it began with the importation of good merino animals, with German shepherds, under the direction of Messrs. Hannah and Sheridan, whose establishment still survives. When fairly commenced the production increased with an accelerating ratio. The exports rose from 944 bales in 1832 to 3,577 in 1840, an increase of 280 per cent. in eight years. In 1850 it attained 17,069 bales, an increase in ten years of 380 per cent.

This republic, with a climate where the cold of winter is so moderate as to exhibit no more severe effects than slight hoar frosts which disappear with the morning's sun, with an extensive seaboard, with an internal and arterial system of rivers, counted among the finest in the world, and with a soil furnished by a rich and vast alluvial plain on a subsoil of silicious clay, would seem to have a capacity for an un-

limited production of merino wool. It would be well if the same could be said of another branch of wool, the product of the same country—that proceeding from the indigenous races, or rather the descendants of the coarse Spanish sheep introduced by the conquerors in the middle of the sixteenth century. These wools, derived from Churros sheep of Spain, which have not been crossed with the merinos, are obtained from flocks found in the Sierra of Cordova, at an altitude of from 3,000 to 5,000 feet, also from other provinces of the Argentine Republic, as shown at the late Exhibition, each known by the name of the province. The wool, long, though coarse, and produced in small fleeces, is in great demand in the United States for the manufacture of carpets. A plateau plain in the province of Cordova, of 800 superficial leagues in extent, at an elevation of 10,000 feet, produces sheep of this race, which bear much larger fleeces of long carpet wools. The tendency is for these wools to constantly increase relatively in value, as they are grown only by the rudest people, who are rather diminishing than increasing in numbers. The question of the future supply of these wools is, therefore, one of serious consideration with carpet manufacturers.

"Lana de Lina" wools are a product of the cross of the sheep and the goat. They resemble in appearance the wools of the sheep of the several provinces where they were grown, but are more wiry and slippery. Dr. Oldendorff, who is a man of thorough scientific and practical information upon all subjects connected with agriculture, and who has resided in Buenos Ayres for twenty years, being now the head of the agricultural department of the Argentine Republic, says that they are the offspring of the male goat and the ewe, never of the ram and the female goat, and are invariably sterile. The skins, dressed, are called *pellones*, and are used by the natives to cover their saddles. In traveling over the mountains, frequently eight or nine are put upon the saddle, on top of which the driver sits. They serve for his bed and covering as he bivouacs at night.

BRAIN OF LIMULUS POLYPHEMUS.*

SEVERAL years ago I attempted to study the brain of the horseshoe crab (*Limulus polyphemus*), and had it sliced into a large number of sections. Owing to interruptions these sections, made from unstained alcoholic specimens, were not examined; during the past winter I have been able, with the aid of Mr. N. N. Mason, of Providence, to take up the study afresh. Mr. Mason has kindly made sections, both transverse and horizontal, stained with osmic acid; also sections of the brain of the supra-œsophageal ganglion of the lobster, stained with picro-carmine, for comparison. The following results, then, are based on over two hundred sections of the supra-œsophageal ganglion of Limulus, but more especially on one brain, which was cut by Mr. Mason into fifty-six sections, from one-one-thousandth to one-five-hundredths of an inch in thickness, and another cut into over forty. The examination of a few sections of the lobster's brain enabled me to comprehend more readily the recent papers of Dietl, Newton, and Krieger on the brain of the Decapodous Crustacea and of the insects, and thus give me a standard of comparison by which to study the topography and histology of the brain of Limulus.

General Anatomy of the Brain.—The singular relations of the central nervous system of the adult Limulus have been fully described and beautifully illustrated by A. Milne Edwards, and Dr. Dohrn and myself have described its general anatomy in the larval stage. The central nervous system of Limulus consists of an œsophageal collar, mostly made up of six pairs of ganglia, from which nerves are distributed to the six pairs of foot-jaws (gnathopods), while the ring is closed or completed in front by the brain, or what corresponds to the supra-œsophageal ganglion of normal Crustacea and insects. In these Arthropoda the brain is situated in the upper part of the head in a plane parallel to but quite removed from that of the rest of the ganglionic chain; in Limulus, however, the brain is situated directly in front of and on the same plane with the rest of the central nervous system. Milne Edwards states that the œsophageal ring, as well as the posterior part of the nervous system, is enveloped by the arterial coat; he also states that the brain and nerves are enveloped in a similar arterial coat, but this we have failed to find; the brain is protected by a thick membrane ("perineurium" of Krieger) formed of fibrous connective tissue, and the nerves are protected by a continuation of this membrane, as several longitudinal sections of these nerves have taught us. The brain in a Limulus, ten inches long, exclusive of the caudal spine, is about five or six millimeters in diameter; it is flattened slightly above, and on the upper side has a shallow median furrow, indicating that it is a double ganglion. Three pairs of nerves and a median unpaired one (the ocellar) arise from the upper third of the anterior face of the brain. The two optic nerves are the largest ones, arising one on each side of the median furrow, so that the fifth to fifteenth sections made by the microtome pass through them. Next below (from above downward) is the origin of the ocellar nerve, which, as described by A. Milne Edwards, is single, arising from the median line; on each side, and in nearly the same plane, arise two tegumental nerves, and directly below a second pair of larger nerves (fronto-inferior tegumental) descend vertically. No nerves arise from the lower half or two-thirds of the brain, which is smooth and rounded, with no median furrow underneath. It will thus be seen that, as stated by A. Milne Edwards, there are no antennal nerves, such as exist, as a rule, in Arthropods, except Arachnida. This we have proved in the same manner as Milne Edwards, by laying open the arterial coat or modified neurilemma, which reaches to the posterior end of the brain, and seeing that the fibers of the nerves sent to the first pair of legs originate quite independently of the brain itself.

Internal Structure and Histology of the Brain.—Transverse sections of the brain throw but little light on the topography, as the nerve fibers extend horizontally, the nerves being sent out horizontally and from the anterior end only of the brain; hence the examination of nearly two hundred sections threw little light on the topography, and considerable time was spent in a vain and baffling attempt at understanding the geography of this ganglion.

The study of two brains, each sliced horizontally into about fifty sections, carefully mounted by Mr. Mason in consecutive order, finally enabled me to arrive at a tolerably complete idea of the relations of parts, so that I could mentally construct a model of the brain of Limulus, and compare it with the normal Arthropod brain.

The histological elements of the brain of Limulus are three in number: 1. Large ganglion cells, filled densely with granules and with a well-defined nucleus similarly filled and with a granular nucleolus. These cells may be crowded or loose, with the granules fewer in number, and with loose, thick cell-walls; they terminate in large fibers, which subdivide. 2. Similar cells, but smaller, with less protoplasm, and like those in the lobster's brain. 3. Nerve fibers; these, like the large sized ganglion cells, from which they originate, are stained tawny yellowish-brown with osmic acid. These fibers are large, coarse, their granular contents very homogeneous, and they closely resemble the nerve fibers distributed to the compound and simple eyes. Certain fibers near the origin of the optic nerves are distinctly nucleated at intervals. 4. Rounded masses, consisting wholly of nuclei, inclosed in a network of fibers, which stain dark brown with osmic acid; these bodies form the larger part of the substance of the brain, while staining dark brown with osmic acid; in unstained alcoholic sections these masses are dark or grayish, the substance of fibers inclosing them being whitish, by transmitted light. The brain is enveloped by a thick perineurium, formed of a fibrous tissue, and some (probably) elastic tissue, which occasionally penetrates into the brain-substance between the white rounded fungoid masses, forming the mesh-work surrounding them. The general topography of the brain of Limulus is on a simple plan compared with that of Decapodous Crustacea and insects. The brain is mostly composed of large, irregular rounded masses or balls of nuclei, with a thick fungoid or ruffle-like periphery, formed by a layer of secondary smaller rounded granular masses. The center of the primary masses is stained paler brown by osmic acid. These masses are often seen in section, rounded, but more often are irregular, not closed, spheroids; these fungoid or nucleogenous bodies extend through the brain like ruffles. The lower half or two-thirds of the entire brain is apparently filled with these nucleogenous bodies, as we may provisionally designate them. In the upper third of the brain, whence the nerves originate, the larger ganglionic cells and the nerve fibers appear, and preserve a definite topographical relation to the entire brain. The nucleogenous bodies are confined at the top to each side of the brain; the central and hinder regions are filled with the large ganglionic cells, mixed with numerous much smaller ones, and the mass of nerve fibers which spring from them becomes larger, from the upper third to the top of the brain, where the optic fibers originate. Opposite the beginning of the optic nerves these large nerve fibers are seen, directed toward the origin of the nerves as if they were the roots, as they undoubtedly are. In the section passing through the ocellar nerve and the tegumentary nerves on each side the fungoid masses are situated in the front of the brain; but they disappear from the front higher up at the origin of the optic nerves, and occupy a much more restricted area on the sides of the brain. Thus the track of nerve fibers on either side of the brain is irregularly wedge-shaped, the apex situated near the center of each hemisphere, and the base spreading out on the top, thus crowding to the outer walls the nucleogenous bodies.

It would thus appear as if the lower half of the brain were in an indifferent state,* and that the dynamic part were confined to the upper third, the region giving origin to the nerves of sensation.

The asymmetry of the brain is remarkable; the large ganglionic cells are most abundant in the center behind the middle, and from there to the posterior side of the brain; a median line is slightly indicated by the arrangement of the fungoid masses. The tract, composed of large nerve fibers with scattered ganglionic cells on the left side, is very much more extensive than on the right.

Comparison with the Brain of other Arthropods.—So wholly unlike in its form, the want of antennal nerves, and internal structure, is the supra-œsophageal ganglion, or "brain," of Limulus, to that of insects and the higher Crustacea, that it is very difficult to find any points of comparison.

Histologically, judging by my specimens of the brain of the lobster, which are stained with carmine, the brain of Limulus agrees with that of other Arthropods in having similar large ganglion cells; the smaller ganglion cells, so abundant in the brains of insects and Crustacea, are wanting in Limulus. There are, in Limulus, no *ballen-substanz*-masses homologous with those of the other Arthropods, nor any "mushroom" bodies.

Topographically, the internal structure of the brain of Limulus is constructed on a wholly different type from that of any other Arthropodous type known, so much so that it seems useless to attempt to homologize the different regions in the two types of brain. The plan is simple in Limulus; much more complex in Arthropods, especially in the brain of the craw-fish, as worked out by Krieger, as in the Decapodous brain there arise two pairs of antennal nerves besides the optic pair, and in external form the two types of brain are entirely unlike. The symmetry of the brain of the craw-fish, as of the lobster and insects, is marked throughout, each hemisphere exactly repeating in its internal topography the structure of the opposite side; the symmetry of that of Limulus is obscure and imperfect.

* Read at the meeting of the National Academy of Sciences, held at Washington, April 21, 1880.

* This area, made up of granules and nuclei, seems really to be connective tissue, and to represent the connective tissue in which the ganglia of the embryo of the young larva are embedded. There seems no reason why the brain should not be partly formed from connective tissue as much as the remaining ganglia, as we have seen them to be in different sections of different ganglia, all or nearly all except the supra-œsophageal one.

AN UNFORTUNATE WHITE WHALE.

THE Duke of Sutherland has presented to the Museum of the Royal College of Surgeons the skull of a white whale (*Delphinapterus leucas*), taken alive near Dunrobin, which presents a most remarkable evidence of an old extensive injury and subsequent recovery. This cetacean has been but very rarely observed in the British seas, and there would seem to be but one other recorded instance of one having been caught alive. The specimen in question was, writes the Rev. Dr. Joass, of Golspie, found close to the salmon nets near the Little Ferry, about three miles to the westward of Dunrobin, on the 9th of June, 1879. It was caught by the tail between two short posts to which a stay rope of a net was fastened, and a salmon of 18 lb. weight, which was supposed to have been the object of its pursuit, was found in front of it. It measured 12½ feet in length. In its efforts to escape it had broken its back between the third and fourth lumbar vertebræ, and it had a recent wound on the front of its head, nearly five inches long and three broad. It was seen two days before its capture, and the fisherman, seeing it approaching against the ebb, took it for a ghost. Professor Flower, in exhibiting the prepared skull to the Zoological Society of London, stated that the skeleton showed that the whale had been a perfectly adult animal, that the atlas had been dislocated off the occipital condyles, and this completely so, and the bones had afterwards become firmly fixed by deposits of new bony matter in such a way as to enormously narrow the aperture for the passage of the spinal cord. There was no appearance whatever of any disease of the bones, and there could be no reasonable doubt but this dislocation was the result of accident. It is certainly difficult to imagine how such an accident could have happened; such a dislocation is often brought about by a fall on one's head, but aquatic animals are not liable to such a catastrophe—even, thinks Professor Flower, a violent collision of the head against a rock or ship could scarcely have brought it about. It seems marvelous that after such an accident the unfortunate whale could have contrived to pursue and capture living prey. For a time, it would almost seem certain, its general powers must have been interfered with. After recovery its head was fixed quite awry on its body, and this may account in some measure for its wandering so far from its natural home and for the facility of its capture.

ETHEREAL OIL OF CALIFORNIA BAY TREE.

By J. M. STILLMAN.

THE California bay tree, known under the different botanical names of *Oreodaphne Californica, Laurus Californica, Tetranthera*, and latterly *Umbellaria Californica*, is a large and beautiful evergreen tree, very common to the valleys and water courses of the coast mountains of California. It often attains great size, and its timber is much used under the name of "California laurel" for veneering and fine cabinet work. The leaf is in shape something like the laurel, but lighter in color and narrower. Both leaf and wood have a very fragrant aromatic odor, which when strong, as in the crushed leaf, excites mucous surfaces, brings tears to the eyes, and produces headache.

The oil was obtained by distilling the leaves (which were gathered in March, 1879, when the trees were in bloom) with steam. In the neighborhood of sixty or seventy pounds of the fresh leaves were placed in a large barrel with perforated false bottom, and steam from the escape-pipe of a steam-boiler forced through the mass and condensed. In order to avoid the accumulation of too large an amount of water, this was siphoned off from the bottom of the receiving bottle, the siphon dipping into a dish of water by the side of the bottle, and the overflow of this dish kept the water in the bottle at a constant level. At the end of two days there were obtained in this way 820 grammes of the oil. The oil as thus obtained is of a clear yellowish or straw color, of the peculiar aromatic odor of the leaf, specific gravity at 11° C. 0·94. By long standing (nearly a year) it does not thicken.

Subjected to fractional distillation it gives up a small quantity of dissolved water, and separates into two principal fractions, one boiling from 170–190° C. and the other from 210–225°, with smaller quantities passing over as high as 260°.

The lower fraction mentioned was subject to repeated fractional distillation, and gave a considerable quantity of a clear, colorless, mobile liquid boiling at 167–168°, though apparently with slight dissociation, as traces of water appeared in the first portions of the distillate at each distillation, which were not to be got rid of by repeated distillation and removing the first portions of each distillate. A portion of the purest of this substance from 167–168° C. was subjected to elementary analysis.

		I.	II.	Mean.	Calculated for $C_{20}H_{32}.H_2O$.
C	..	82·91	82·46	82·68	82·76
H	..	11·93	11·68	11·80	11·72

It will be seen that the agreement is very close with the composition of a hydrate of turpentine in which one molecule of water is combined with two of $C_{10}H_{16}$ or one of $C_{20}H_{32}$.

This agrees with the terpinol of Wiggers, investigated and named by List, and obtained in various ways from the turpentine dihydrate $C_{10}H_{16}.2H_2O$. The boiling point of terpinol is given at 168°, and it is a colorless liquid of pleasant aromatic odor. The odor of the compound analyzed is not unlike that of spirits of camphor, though not quite identical.

It is not readily affected by metallic sodium even when heated with it. The water is therefore in intimate combination, possibly as an ether $(C_{10}H_{17})_2O$.

A vapor density determination was made by Mr. J. B. Wilcutt according to Victor Meyer's method, in diphenylamine vapor. The result in one case gave 4·7, whereas the vapor density calculated for $C_{20}H_{34}O$ would give 10·0. If, however, dissociation should take place, splitting up the molecule into $C_{20}H_{32}+H_2O$, the vapor density of the mixture would be 5·0, not so far from the result obtained. That dissociation would take place was to be foreseen from the behavior on distillation, and was confirmed by the fact that after the operation the contents of the apparatus no longer had the original camphor-like odor, but possessed a distinct, rank odor of turpentine. It was also noticed that the compound itself by long standing bleached the cork of the test-tube, probably due to the traces of the free $C_{20}H_{32}$ resulting from the distillation.

An analysis was made of a fraction boiling at 171–172°, which gave C=81·39; H=11·40. Evidently therefore a mixture of the above with the more oxygenated, higher-boiling constituent, umbellol, $C_8H_{12}O$.

The higher fraction (210–225°) was also subjected to fractional distillation and a compound obtained in considerable quantity, boiling without decomposition at 215–216° (uncorrected). This substance is also a colorless mobile liquid of aromatic but powerful odor which, too strongly inhaled, attacks the mucous surfaces and causes headache. It is but slightly volatile, a quantity in an open watch-glass losing one mg. in an hour and a half. With concentrated sulphuric acid it gives a blood-red color, turning to brown and black. Water separates it from its solution in the acid. It is acted on violently by sodium, forming a blood-red, brittle resinous substance; it is also acted on violently and decomposed by strong nitric acid. Elementary analysis gave

		I.	II.	III.	Calculated for $C_8H_{12}O$.
C	..	77·28	77·27	77·17	77·42
H	..	9·74	9·53	9·57	9·67

The vapor density determined, with the assistance of Mr. F. Slate, according to Victor Meyer, in diphenylamine vapor gave 4·39; calculated for $C_8H_{12}O$=4·29. The formula is therefore $C_8H_{12}O$.

It is isomeric, as far as I know, with no other known compound. It is homologous as far as its empirical formula is concerned with common camphor, but has different properties.

Analysis III. above was made two or three months later than the other two, after the substance had been standing in a test-tube corked, with occasional removal of the cork. It will be noticed that oxidation is very slow if it takes place

at all, though a faint tint of yellow seemed to indicate such action. Experiments have been commenced with the object of determining the nature of these substances and their chemical constitution if possible, and I intend to subject the reactions and derivatives of these interesting compounds to an extended investigation. As other duties, however, entirely occupy me at present, I have been compelled to postpone further investigation on this subject for some months. I therefore make this preliminary report and take the opportunity to reserve the ground for future work.—*Amer. Chem. Journal.*

[Continued from SUPPLEMENT No. 234, page 3730.]

FOREST TREES OF NORTH AMERICA.

By CHARLES S. SARGENT, Arnold Professor of Arboriculture in Harvard College, Special Agent Tenth Census.

275. *Juniperus occidentalis*, Hook. *J. excelsa*, Pursh. Oregon and Idaho, south to California, on the high Sierra Nevada. In Oregon, a large tree; smaller in California, or often reduced to a shrub.

Var. monosperma, Engelm. Trans. St. Louis Acad. iii. 590. Pike's Peak, Colorado, through Western Texas and New Mexico to Arizona and Southern California. A shrub or small tree.

Var. ? conjungens, Engelm, l. c. "Western Texas, where it forms forests and is an important timber tree, although not as large nor as easily worked and useful as the Red Cedar of the plains of Eastern Texas."—Lindheimer.

276. *Juniperus pacyphlæa*, Torr. *J. plochyderma*, Torr. in Sitgr. Rep. t. 16. New Mexico and Arizona. "A middle-sized tree, with a spreading, rounded top, thick, and much cracked bark, and pale, reddish wood."—Engelm. Trans. St. Louis Acad. iii. 589.

277. *Juniperus Virginiana*, L. (Red Cedar. Savin.) New Brunswick and Canada up to latitude 45° north; south to Florida, and west to British Columbia, Washington Territory, and Eastern Texas; not in Western Texas, California, or probably Oregon; rare in Utah, Arizona, and Central Nevada. Heart-wood red, aromatic, close-grained, compact, very durable; largely employed in cabinet-making, for fence posts, railway ties, pencils, etc. A tree sometimes 60 to 80 feet in height, or, near its northern limit, reduced to a low shrub or small tree. The most widely distributed and one of the most valuable of North American *coniferæ*.

278. *Cupressus Goveniana*, Gordon. "A shrub or small bushy tree 6 to 10 feet high or more. California, in the coast ranges from about Monterey to Sonoma County. In Marin County it is said to sometimes attain a height of 40 to 80 feet. A doubtful form is reported from Cedar Mountain, Alameda County (Dr. Kellogg), described as a handsome tree, 30 to 40 feet high, of dense symmetrical growth."—Watson, Bot. Cal. ii. 114, ined.

279. *Cupressus Macnabiana*, Muir. California, "about Clear Lake (Torrey, Bolander); originally reported by Jeffrey from Mount Shasta, at 5,000 feet altitude. "A shrub or small tree, 6 to 10 feet high or more."—Watson, Bot. Cal. ii. 114, ined.

280. *Cupressus macrocarpa*, Hartw. *C. Lambertiana*, Gord. *C. Hartwegii*, Carrière. (Monterey Cypress.) California, "on granite rocks near the sea; from Point Pinos, near Monterey, southward four or five miles to Pescadero Ranch. The largest measurement recorded (Brewer) is a circumference of trunk 18½ feet, at a height of five or six feet from the ground."—Watson, Bot. Cal. ii. 113, ined. A tree 40 to 70 feet in height. These species are still very imperfectly known, and the attention of California botanists is called to the importance of studying, in the field, the various species of *cupressus* native of their State.

281. *Chamæcyparis Lawsoniana*, Parl. in DC. Prodr. xvi.², 464. *Cupressus Lawsoniana*, Murr. *Cupressus nutkaensis*, Torr. Bot. Wilkes, t. 16. *Cupressus fragrans*, Kellogg. *Cupressus attenuata*, Gordon. (Oregon Cedar. White Cedar.) Oregon and southward along the coast ranges to the Mount Shasta region, Northern California. Wood white; fragrant, close-grained, compact, elastic, free of knots, easily worked, very durable. A large tree, 100 to 150 feet in height, with a trunk 2 to 6 feet in diameter.

282. *Macyparis nutkaensis*, Spach. *Thuya excelsa*, Bong. *Cupressus nutkaensis*, Lamb. *Cupressus Americana*, Trautv. *C. excelsa*, Fisch. *Thuyopsis borealis*, Hort. *Thuyopsis Tchugatskoy*, Hort. Sitka; southward to the Cascade Mountains. Wood white, soft, clear, easily worked; susceptible of a beautiful polish; probably very beautiful. A tree sometimes 100 feet in height.

283. *Chamæcyparis sphæroidea*, Spach. *Cupressus Thyoides*, L. *Thuya sphæroidalis*, Rich. (White Cedar.) Essex County, Massachusetts; south to Florida, near the coast, and in Wisconsin. Wood reddish, light, soft, fine-grained, easily split and worked, very durable; employed for shingles, in boat building, cooperage, and largely for railway ties, posts, fencing, etc. A tree 40 to 80 feet in height, with a trunk often 2 to 3 feet in diameter; always in deep, cold swamps.

284. *Thuya gigantea*, Nutt. *T. plicata*, Donn. *T. Menziesii*, Dougl. (Western Arbor Vitæ.) Sitka, and southward through the coast ranges and the Cascade Mountains to Northern California. Wood light-colored, soft, easily worked, moderately durable; used for shingles, and often sawed into boards, although liable to split and warp when exposed to the sun. A large tree, 100 to 150 feet in height, with a trunk 3 to 12 feet in diameter.

285. *Thuya occidentalis*, L. (Arbor-Vitæ. White Cedar.) James' Bay and the Saskatchewan, south through British America, except Newfoundland and Nova Scotia; common in the Northeastern States to Pennsylvania, and occasionally along the Alleghany Mountains to North Carolina; west to Northern Michigan and Wisconsin. Wood light-colored, compact, light, very durable; largely employed for posts, railway ties, fencing, etc. A small tree, 20 to 50 feet in height, with a trunk 1 to 3 feet in diameter; in swamps and along the rocky banks of streams.

286. *Libocedrus decurrens*, Torr. *Thuya Craigiana*, Balfour. *Thuya gigantea*, Carrière. *Heyderia decurrens*, Koch. (White Cedar.) Oregon, to San Diego, California; in the coast ranges and in the Sierra Nevada, up to 8,500 feet elevation. Wood light-colored, soft, and said to be durable. A large tree, 100 to 150 feet in height, with a trunk 4 to 7 feet in diameter.

287. *Taxodium distichum*, Richard. *Cupressus disticha*, L. (Bald Cypress. Black Cypress. White Cypress. Deciduous Cypress.) Southern Delaware to Southern Florida, near the coast; and from Carroll County, Indiana, Southern Illinois, and Missouri, south to Alabama, Louisiana, and Eastern Texas. Wood reddish, strong, light, compact, easily split and worked, very durable. Largely used in construction in the form of boards and square timber, for shingles, posts, railway ties, fencing, etc. A large tree, sometimes reaching, under favorable circumstances, in the Southern States, a height of 150 feet, with a diameter of trunk of 10 to 12 feet or more; in swamps or the inundated borders of streams; one of the most valuable trees of the North American forests.

288. *Sequoia gigantea*, Decaisne. *Wellingtonia gigantea*, Lindl. *Washingtonia Californica* (*Taxodium Washingtonianum*), Winslow. *S. Wellingtoniana*, Seem. *Taxodium giganteum*, Kell. and Behr. (Big Tree.) California, along the western slopes of the Sierra Nevada at about 4,000 feet elevation from Placer County to Deer Creek, on the southern borders of Tulare County; in small or isolated groves, except toward its southern limit where it forms an extensive forest, some 40 miles in length by 6 to 8 miles in width. Wood dull red, very light, and remarkably durable. (See Muir in Proc. Amer. Assoc. xxv. 242.) The largest tree of the American forests. "It has an average height of 275 feet, with a trunk 20 feet in diameter; the largest measurement being 366 feet in height, and a diameter of 35 feet 8 inches within the bark, at four feet above the ground."—Watson in Bot. Cal. ii. 117, ined.

289. *Sequoia sempervirens*, Endl. *Taxodium sempervirens*, Lamb. *Schubertia sempervirens*, Spach. (Red Wood.) California, from the northern portion of the State, south only in the coast ranges to San Luis Obispo. Wood red, light, close-grained, compact, easily split and worked, susceptible of a fine polish, and very durable; largely sawn into boards and shingles; and furnishing the common and cheapest lumber, railway ties, posts, and fencing, of the Pacific coast. The forests of this species are economically the most valuable of California, but owing to their accessibility to tidewater are in great danger of speedy extermination. "In size the red wood usually averages 8 to 12 feet in diameter, and from 200 to 300 in height, with a straight cylindrical barrel, naked to the height of 70 to 100 feet or more."—Watson in Bot. Cal. ii. 117, ined. This species is remarkable for its tenacity of life, the stumps and roots throwing up for a long time great numbers of vigorous suckers.

290. *Abies balsamea*, Marshall. *Pinus balsamea*, L. *A. balsamifera*, Michx. *Picea balsamea*, Loud. (Balsam Fir. Balm of Gilead Fir.) Canada, Nova Scotia, and the Northeastern States, south along the Alleghany Mountains to Virginia; west along the great lakes to Wisconsin and Minnesota. Wood white and soft; occasionally made into shingles, but of little value. A tree sometimes 70 feet in height, with a trunk rarely exceeding 18 inches in diameter; in cold, damp woods, and mountain swamps, or at high elevations reduced to a prostrate shrub.—A. Hudsoniana, Hort.

291. *Abies bracteata*, Nutt. *Pinus venusta*, Dougl. *Pinus bracteata*, Don. *Picea bracteata*, Lindl. Southern California, only in the Santa Lucia Mountains, at an elevation of 3,000 to 6,000 feet. A little known tree, 100 to 150 feet in height.

292. *Abies concolor*, Lindl. *Picea concolor*, Gordon. *Pinus concolor*, Engelm. *A. Lowiana*, Murr. *A. grandis*, of the California botanists. *A. amabilis* (?) Watson, King, Rep. v. 333. *A. lasiocarpa*, Hort [not Hook]. *A. Parsoniana*, Hort. *A. amabilis*, Hort. (White Fir.) From Southern Oregon through the Sierra Nevada, at 3,000 to 8,000 feet elevation, and through the mountains of Oregon to Utah and Southern Colorado. Wood probably of little value. A large tree, 80 to 150 feet in height, with a trunk 2 to 4 feet in diameter.

293. *Abies Fraseri*, Lind. *Pinus Fraseri*, Pursh. Only on the summits of the peaks of North Carolina and Tennessee?, which exceed 6,000 feet in height. Wood white, soft, of little value. A small tree, 20 to 40 feet in height, with a trunk not exceeding 18 inches in diameter.

294. *Abies grandis*, Lindl. *Pinus grandis*, Dougl. *Pinus amabilis*, Dougl.? [not of later authors]. *Picea grandis*, Loud. *A. Gordoniana*, Carrière. British Columbia, south to Mendocino County, California, near the coast. Wood considered valuable. The largest species of the genus, reaching 200 to 300 feet in height, with a trunk 3 to 4 feet in diameter.

Var. densiflora, Engelm., Trans. St. Louis Acad. iii. 594. Base of Mount Hood to British Columbia.

295. *Abies magnifica*, Murr. *A. amabilis*, of the California botanists. (Red Fir.) "The Red Fir of the higher Sierras is not rare at an altitude of 7,000 to 10,000 feet, but forms no forests by itself. Easily distinguished from the next species by the inclosed bracts. Forms, however, are said to occur (Mount Silliman—Brewer), with exserted bracts, and it remains to be seen whether the slight differences in the leaves, scales, and seeds will suffice to keep the species separate."—Engelm., in Bot. Cal. ii. 119, ined. A large tree, 200 feet or more in height, with a trunk 8 to 10 feet in diameter.

296. *Abies nobilis*, Lindl. *Pinus nobilis*, Dougl. *Picea nobilis*, Loud. Base of Mount Shasta, California, where it forms extensive forests at an elevation of 6,000 to 8,000 feet, and north through the Cascade Mountains to the Columbia River. Wood said to be more valuable than that of the other species of the genus. A large tree, 200 feet in height.

297. *Abies subalpina*, Engelm. *A. lasiocarpa*, Hook, Fl. Borr. Am. ii. 163? [not Hort.]. *A. bifolia*, Murr. *A. amabilis*, Parl. in DC. Prodr. xvi.² 426, in part. *A. grandis*, of the Colorado botanists. "It extends from the higher mountains of Colorado and the adjoining parts of Utah, northward to Wyoming and Montana, where it is the only species, and westward to the mountains of Oregon, and into British Columbia (Fraser River), and southward probably to Mount Shasta; always scattered in the subalpine forests, and, at least, in Colorado, coming up almost to timber limit; but never alone constituting forests."—Engelm., Trans. St. Louis Acad. iii. 597.) Wood light-colored, soft, almost worthless. A tree 60 to 100 feet in height, with a trunk often more than 2 feet in diameter.

Var fallax, Engelm, l. c. (*A. amabilis*, Newberry, Pac. R. Rep. vi. 51.) High summits of the Cascade Mountains, south of the Columbia River, and in the Wasatch Mountains, Utah.

298. *Pseudotsuga Douglasii*, Carrière. *P. Douglasii*. Sabine. *Abies Douglasii*, Dougl. *Tsuga Douglasii*, Carrière. (Douglas Spruce.) Oregon and California, in the Coast Ranges, and along the west flank of the Cascade and Sierra Nevada Ranges up to 6,000 to 8,000 feet elevation, extending south into Mexico, and east through Arizona and New Mexico to the Rocky Mountains of Colorado. Wood yellow or reddish, coarse-grained, heavy, strong; largely sawn into boards and square timber; used for masts, spars, etc. A tree 200 to 300 feet in height, with a trunk 8 to 15 feet in diameter; the most valuable timber tree of Oregon, reaching there its greatest development, and forming probably the heaviest forest growth known.

Var. macrocarpa, Engelm. Bot. Cal. ii. 120, ined. (*Abies macrocarpa*, Vasey in Gard. Monthly, June, 1876.) Southern California, in the cañons of the foothills of the San Bernardino Mountains and in the San Felipe Cañon. A small and little known tree, 40 to 50 or rarely 80 feet in height, with a trunk 2 to 3 feet in diameter; cones much larger than in the species.

299. *Tsuga Canadensis*, Carrière. *Pinus Canadensis*, L. *Abies Canadensis*, Michx. *Picea Canadensis*, Link. (Hemlock.) Northern New Brunswick, through the valleys of the St. Lawrence and upper Ottawa Rivers to the western shore of Lake Superior; south through the Northern States and along the Alleghany Mountains south to Habershaw County, Georgia. Wood light-colored, coarse, and crooked-grained, light, very liable to splinter; largely sawn into boards of an inferior quality. A tree 70 to 80 feet in height, with a trunk 2 to 3 feet in diameter; in rather dry, rocky situations, generally on the north side of hills; of great economic value on account of its bark, which is richer in tannin than that of any common tree of the Northeastern States.

(To be continued.)

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